APPENDIX K

Haile Gold Mine EIS

Supporting Information and Analysis for Wetlands

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APPENDIX K1

TECHNICAL MEMORANDUM

RATIONALE FOR WATER LEVEL CHANGE CRITERIA FOR EVALUATING INDIRECT EFFECTS IN WETLANDS AT THE PROPOSED HAILE GOLD MINE

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bgs	below ground surface
CPS	Coastal Plain Sand
ERC	Ecological Resource Consultants, Inc.
HGM	hydrogeomorphic
UMAM	Florida's Uniform Mitigation Assessment Method
USACE	U.S. Army Corps of Engineers

K1 TECHNICAL MEMORANDUM RATIONALE FOR WATER LEVEL CHANGE CRITERIA FOR EVALUATING INDIRECT EFFECTS IN WETLANDS AT THE PROPOSED HAILE GOLD MINE

K1.1 Objectives

This technical memorandum is being supplied as partial support for the evaluation of potential indirect effects of pit depressurization (groundwater lowering) at the Haile Gold Mine on wetland hydrology and ecology relative to predicted changes in groundwater levels and seepage regimes. The term “Project site” is used to encompass the general area within and near the Haile Gold Mine Project boundary within which wetlands potentially may be affected by mining activities.

The memorandum starts with an overview of wetlands and wetland hydrology at the Project site and in the region, and then presents a summary of relevant literature on wetland hydrology as related to wetland ecology, with a focus on the primary type of wetlands found at the Project site—slope wetlands. Subsequent sections provide a basis for estimating, from the literature and available studies, the general magnitude of in-wetland water level changes that may be expected to result in various levels of indirect wetland impacts. These thresholds of in-wetland water level changes can be used as a general measure of wetland impact if the actual expected water level change was known. However, the actual in-wetland water levels as related to aquifer level drawdowns were not predicted by the groundwater model (Cardno ENTRIX 2013). The relationships between aquifer drawdown and resultant wetland hydrology can be complex, and one would not expect the relationship to be one-to-one or the same over the entire Project site. Consequently, the available information on measured wetlands water levels and nearby surficial aquifer levels at four areas within the Project site was evaluated to assess the likely response and expected variability over the Project site.

K1.2 Background

The proposed Haile Gold Mine lies in the Sandhills ecoregion that forms the border between the Coastal Plain and Piedmont ecoregions in South Carolina. In this area, fractured crystalline bedrock is overlain by saprolite and alluvial Coastal Plain Sand (CPS) deposits. Where present, the saprolite unit partially separates the CPS aquifer from the underlying bedrock aquifer. The groundwater table generally reflects topography, with depths to groundwater typically being less than 30 feet below ground surface (bgs). Depths to groundwater tend to follow the topography and have been shown to be generally closer to the surface in topographically low-lying areas and to be at greater depth in topographically high areas. Hydrological studies indicate that neither the saprolite nor the CPS includes effective confining units (Cardno ENTRIX 2013).

The Groundwater Modeling Summary Report for the Haile Gold Mine (Cardno ENTRIX 2013) indicates that the shallow and deep aquifers are hydraulically connected. Groundwater generally flows from recharge in the upland areas of the watersheds and discharges into Camp Branch Creek and Haile Gold Mine Creek (as well as other tributary headwaters), which then flows into the Little Lynches River. The distribution of discharge is believed to be variable along the run of the creeks and is controlled by the hydraulic conductivity of the aquifer and its connection to surface waters. The magnitude of groundwater discharge to the surface water system is variable. The distribution of cracks in the bedrock and continuity of the saprolite layer are important to vertical hydraulic conductivity.

Most wetlands on the Project site lie at the heads of small tributaries that feed Haile Gold Mine Creek or Camp Branch Creek and along lower side slopes of small tributaries. These wetlands have been delineated in accordance with the 1987 U.S. Army Corps of Engineers (USACE) delineation methodology (USACE 1987). In accordance with USACE permit application requirements, the wetlands have been described on data sheets using the National Wetland Inventory classification system (Cowardin et al. 1979).

Further investigation, including on-site hydrological analyses and available literature, has resulted in these wetlands being classified as slope wetlands consistent with hydrogeomorphic (HGM) terminology (Brinson 1993; Smith et al. 2013; Noble et al. 2007). Such wetlands are defined as having seepage as their source of water. They are found in areas with discharge of groundwater to the land surface. The description indicates that there is typically a narrow ephemeral channel that serves to convey water away from the wetland, rather than deliver water to it. Precipitation is a secondary contributing source of water. Water movement is dominantly downslope and unidirectional. Most of the slope wetlands on the Project site are on obvious slopes, but those that occur along somewhat larger streams are at least partially in flatter landscapes and likely have some of their water supplied by the stream system. The general hydrological pattern is depicted in Figure K1-1.

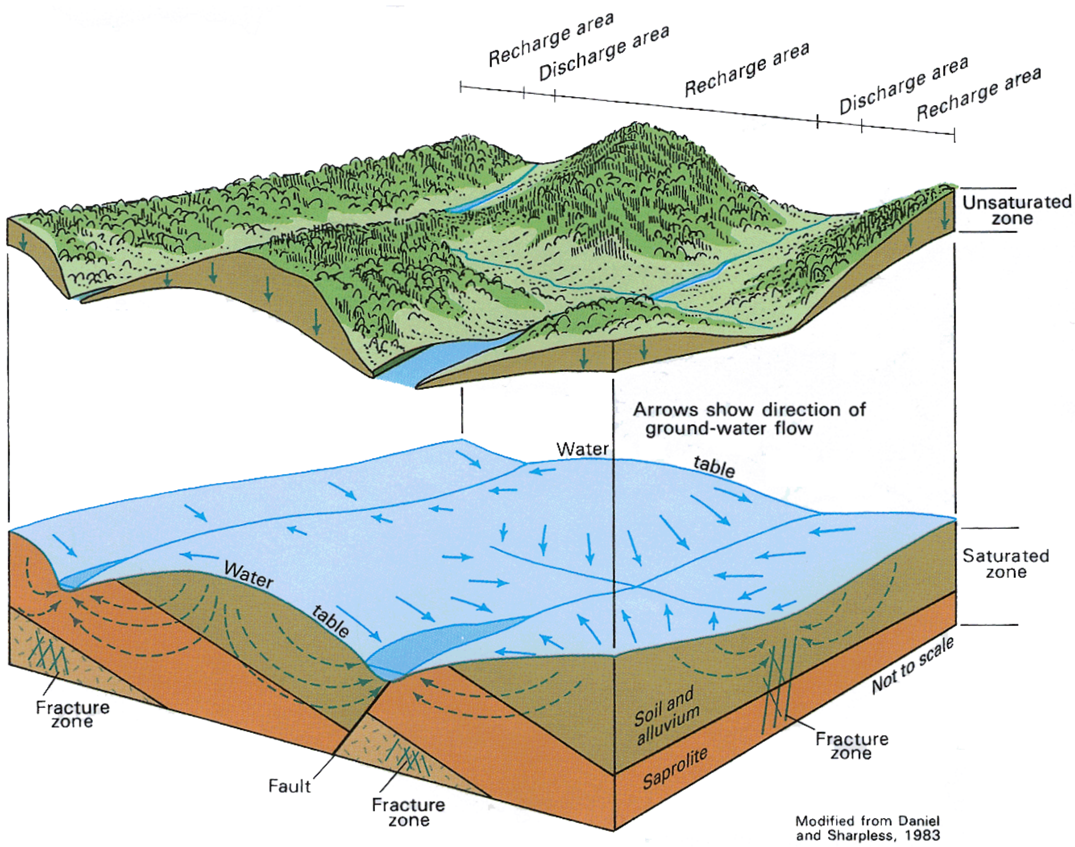

Figure K1-1 General Depiction of the Piedmont Groundwater System

Note: Groundwater percolates downward through the unsaturated zone (shown lifted up) to the water table and then moves laterally to discharge points. In the bedrock, water is channeled through fractures (Miller 1990). The area of the Haile Gold Mine Project would be similar except that much of "soil and alluvium" layer above the saprolite consists largely of Coastal Plain Sands.

Slope wetlands lose water primarily by saturated subsurface flows, via low-order streams, and by evapotranspiration (Noble et al. 2007, 2011). On the Project site, most of the slope wetlands have small drainages within them, and a few have small streams. Based on 2-foot contour LiDAR data, it appears that most wetlands on the Project site are very shallow and have an approximate 2-foot change in elevation from the edge to a center that contains a small drainage. The wetlands become somewhat deeper as the valleys in which they lay get deeper relative to the surrounding hills, and there is more upstream area and elevation to support seepage. Wetlands on the Project site are in 0- to 3rd-order stream valleys.

No HGM classification has been developed for the Sandhills region, but most aspects of HGM procedures for headwaters slope wetlands in Alabama and Mississippi (Noble et al. 2007) and the Coastal Plain of South Carolina (Noble et al. 2011) are relevant to this evaluation.

Several state-level wetland classifications provide general descriptions of slope wetlands in the South Carolina Sandhills belt or its continuation into North Carolina (Schafale 2012; Schafale and Weakley 1990; SCDNR undated). These classifications are based on physiographic region, topographic position, plant and animal communities, and hydrology. All of the above references note the presence of seepage, and these and others describe slope wetlands as having mineral soils, long-term saturation, and little water level fluctuation (for instance, see SCDNR undated; Kinser et al. 1995, 2003, 2006; Rheinhardt et al. 2000). Available literature (Tiner 2005; Tufford 2011) also notes that not all seepage wetlands in the region have these characteristics.

A study of toe slope wetlands in the Virginia Piedmont (Dobbs 2012) concluded that groundwater flows to wetlands depend on the frequency of rainfall and that, in some months, groundwater may contribute as much as 45 percent of water inputs. Piezometer data showed that seepage extended from the valley edge out into the valley throughout the year. Hydraulic head fluctuations in hill slope and toe slope wetlands correlated strongly with estimates of watershed recharge even where saprolite dominated.

K1.3 Wetland Hydrology as Related to Wetland Ecology

Wetland ecology is a function of hydrology, past conditions, and non-hydrological alterations (such as land use changes in the watershed, water quality, and the availability of native and non-native species for colonization) that affect wetland species composition and function. The importance of all of these factors is well documented. The importance of climate change and migration of species at continental and geological scales also has been documented by many studies. Wetlands that exist in the Southeast today have been shaped by many cycles of natural climate change (Enfield et al. 1999; Dawson et al. 2003; Donders et al. 2005), including periods of warmer and cooler temperatures, variations in rainfall spatial and seasonal patterns, species migrations—especially after the last continental glaciation (for example, Griffin and Barrett 2004), and land management by indigenous peoples. Current wetland condition also is influenced by more recent history, including current and past ditching, logging history in the wetland and adjacent uplands (Perison et al. 1997; Cowell 1998), disease and disturbance agents (e.g., feral hogs, chestnut blight, and Dutch elm disease), and other factors.

Wetlands respond to extreme events with effects that are often localized and of short duration, such as hurricanes, tornadoes, fires, floods, ice storms, and droughts (for example, see Allen et al. 1997; Deng et al. 2010; Huddle and Pallardy 1999; Peterson and Pickett 1995). These events are natural, but the effects can sometimes persist for a long time, especially if they alter hydrologic conditions or cause major damage to a forest canopy (e.g., Farris et al. 2007; Romano 2010). Some stressors (e.g., decadal wet and dry cycles; periodic drought, fire, and freezes) are essential for maintaining wetland ecosystems (Frederickson 1991; Shipley and Parent 1991). Global events such as volcanic eruptions and climatic variations mediated by periodic shifts in ocean currents also affect wetlands and how they respond to more local stressors.

Wetland vegetation and soils generally respond in predictable ways to changes in hydrology, regardless of the cause of the change. The nature of the change may vary depending on system type (for instance, Palanisamy and Chui 2012; Webb et al. 2012; Lee 2002; Wloskinski and Kolijord 1996). There are documented relationships between the autecology of component species and the way that those species will respond to changes in hydrology (for instance, Darst and Light 2008). These relationships can be complex (Ryan and Way 2011) and vary by species. At least some changes, such as growth rates of wetland species, are likely mediated by physical changes, such as reduced evapotranspiration when the water table is low (Sumner et al. 2012). Recent studies have addressed the question of how much water is needed by a stream, its bordering wetlands, and isolated lakes and wetlands through various environmental flow and levels assessments (for example, see Tharme 2003; Zhang et al. 2011). An environmental flow assessment typically addresses how much of the original flow regime of a stream needs to flow down it and its bordering wetlands in order to maintain specified and desired aspects of the ecosystem. Other studies (Middleton 2002; Neubaur et al. undated) have addressed the return intervals of various flood and drought events that are required to maintain reproduction of component species and preclude invasion by other species deemed to be inappropriate in wetlands and lakes.

The time duration over which hydrologic (and other) stresses are applied to a wetland affects the extent to which changes to wetland vegetation and soils are apparent (for instance, Odland and Moral 2002; Smith et al. 2008; Wilcox 2004; Busch et al. 1998; Rochow 1985). The species composition of a mature swamp canopy may not change for decades or longer after hydrologic conditions change, while the composition of the herbaceous vegetation may change rapidly and dramatically. Changes include disappearance of species that require inundated or saturated conditions, germination failure, invasion by more upland species, and downward shifts of the elevations of community boundaries (David 1996).

The extents to which changes to underlying aquifers system are translated into changes to wetland hydrology varies with topography and variations in the underlying geology (for instance, Tufford 2011; Sacks 2002; Sanderson and Cooper 2008; Mortellaro et al. 1995; SWFWMD 1999; Swancar and Lee 2003; Swancar et al. 2000). In studies of seepage wetlands on the Coastal Plain of South Carolina, the shallow water table in seepage wetlands was shown to be variable over time and to vary between sites, presumably due to local topography, geomorphology, soils, and vegetation (Tufford 2011). At a broad scale, streams and wetlands are known to be either discharge or recharge systems, and may vary temporally and by location within the same stream (Winter 2007). An imposed drawdown could convert a discharge area into a recharge area.

For assessing the condition of wetlands and determining whether the system is experiencing water-related damage (USEPA 2008; Pederson 1998), stress is generally perceived to occur when physical and biotic characteristics of the wetland change, but before the system has adjusted to the new environmental regime to the extent that the initial physical and biotic characteristics are no longer recognized. The most notable changes generally consist of shifts in the distribution or abundance of major plant species, changes in soil composition and structures, or changes in hydrology.

K1.3.1 Vegetation

The kinds of changes that occur in wetland plant communities include changes in dominant species, shifts from species that prefer wetter conditions to species that prefer drier conditions (Black and Black 1989; Pedersen 1998, Laidig 2010, Laidig et al. 2010), and shifts in zonation and features that indicate water level elevations (Carr et al. 2006) within the wetland. Most upland species are intolerant of flooding, and most wetland species have morphological adaptations that allow survival under anaerobic conditions, especially during the growing season (Kozlowski 1997; Sorrell et al. 2000; Visser et al. 2000; Colmer and Voesenek 2009). Recurrence of flooding at a frequency and duration that will eliminate downward shifts of upland vegetation into the wetland edge is necessary for maintaining the size of the wetland per USACE definition and for preventing a shift from wetland to upland species—especially in those parts of the wetland that lose wetland hydrology (for example, see Dunn 2000; Dunn et al. 2008).

Even apparently small changes in average water depth and hydroperiod have been associated with significant differences in vegetation communities in natural wetlands (Bledsoe and Shear 2000; Dunn 2000; Shaw and Huffman 1996; Carr et al. 2006), but it is apparent that some wetland types are more subject to change than others. Where the species present also are found in low uplands, the effects of moderate reductions in hydrology may be less apparent than would occur if the involved species were ones that are adapted to wetter conditions. On the Project site, most of the overstory species that have been listed as occurring in the wetlands have the ability to grow in at least moderately upland conditions, suggesting that overstory changes may be minor. Where there are seepage-dependent species, such as sphagnum mosses, some spring ephemerals, and other species with narrow habitat tolerances, reductions in seepage may result in losses of those species.

Reduction in the level or duration of flooding also is associated with invasion by nuisance species such as introduced honeysuckles, Chinese privet (*Ligustrum sinense*), Japanese knotweed (*Fallopia japonica*), multiflora rose (*Rosa multiflora*) (USACE 2011), Chinese tallow (*Triadica sebifera*) (NRCS 1990; Zedler and Kercher 2004), and several undesirable grasses including fall fescue (*Festuca* sp.) (Carr et al. 2006), herbs and Bermuda grass (*Cynadon dactylon*) (USACE 2010). Likelihood of invasion is highly related to presence of propagules in the vicinity of the system – if only native species are present, likelihood of invasion is low. But if the surrounding areas are dominated by disturbance, likelihood of invasion is much greater. Some invasive species, such as Japanese knotweed are adapted to wetlands and difficult to eliminate even when hydrology is restored.

K1.3.2 Soils

The character of soils that develop in wetlands varies based on substrate and hydrologic regime (for instance, see Bledsoe and Shear 2000), and there is a strong association between soil and vegetation (Yu and Ehrenfeld 2010). Predictable changes to soils that occur in response to water level changes include soil oxidation, compaction, and loss. The most serious change, oxidation, is relevant to organic soils and sometimes leads to increased risk of fire and falling trees (Stephens and Stewart 1977; Reddy et al. 2006; SWFWMD 1999). With the possible exception of very small areas, oxidation is unlikely to be a major issue on the Project site. More subtle changes, such as compaction and loss of hydric indicators, are more likely in slope wetlands that lack organic soils. These types of effects are less studied and are more likely to be easily reversed than oxidation.

K1.3.3 Other Factors

Investigators have identified a long list of other wetland functions that shift in response to dehydration. Investigated changes vary both regionally and between wetland types within regions. Types of changes have included loss of habitat (for example, bunched arrowhead, Baugh and Schlosser 2012), changes in microbial communities (Sims et al. 2013), changes in root and zylem fungal relationships (Kozlowski 1997) that can lead to tree mortality, increased likelihood of stress-related diseases—especially during droughts, reduced sugar content of trees (Bacchus et al. 2000), changes in carbon isotopes (Anderson et al. 2005), effects on birds breeding and nesting success (Brazner et al. 2007; Emery et al. 2009), loss of reproductive habitat for amphibian populations (Guzy et al. 2006), changes in wildlife and fish populations and abundance (Hill and Cichra 2002a, 2002b;USEPA 2002a), changes in macroinvertebrate communities (Carlisle et al. 2012; Silver et al. 2012), increased fire frequency and increased soil respiration (Flanagan and Sred 2011 as cited in Grant et al. 2012) and reduced wetland ecosystem productivity (Grant et al. 2012). Some of these changes are difficult to reverse, especially if there is significant tree mortality or if a species is eliminated from the local area without potential for recolonization.

K1.3.4 Wetland Relationships to Water Quality

Wetlands are frequently cited as a natural way to capture excess nutrients and selected pollutants (for instance, Dierberg and Brezonik 1985; USEPA 2002b). They also release nutrients into the water column when vegetation dies back during dry periods or droughts, or after fires occur. Changes in wetland water depths and length of hydration can affect water quality conditions, including temperature, oxygen saturation, and nutrient cycling, as well as rates of soil accretion and loss of organic materials by oxidation. Water quality changes continually depend on the predominant water source and biological activity (Haag and Lee 2010). Generally, lower water levels result in higher temperatures, which lead to lower concentrations of dissolved oxygen in the remaining water and resulting stress conditions for aquatic life (Reiss et al. 2009). Release of nutrients from wetlands due to disturbance, dry conditions, or fires can lead to periodic degradation of water quality in downstream lakes, rivers, or wetlands (Galloway et al. 1999; Smith et al. 2001; Neary et al. 2008; Wright 2013). Seepage water from hill slopes and slope wetlands can influence water chemistry in the wetland itself and in the receiving stream (Grabs et al. 2012).

Wetlands also shift in character in response to water quality, both in terms of natural variations in the character of water and changes due to human actions in the environment. A key natural factor is pH. pH strongly affects the availability of nutrients to the plant for growth; both extremely low and extremely high pH potentially cause key nutrients to become less available or unavailable. Because plant species vary in their response to pH changes, any shift in pH may result in a gradual shift in species composition toward one more adapted to the new pH regime. For example, ericaceous species and many evergreen hardwoods are tolerant of (and may even require) somewhat low pH, while others may become less robust or die out. pH also may mediate the availability and uptake of other ionic materials that may be toxic. Based on information provided in the Haile Gold Mine EIS, major changes in pH are not anticipated; therefore, pH is assumed to not be an indirect impact.

K1.3.5 Animal Communities

Animal populations and communities respond over different time periods to changes in their environment. Macroinvertebrates may complete several life cycles each year and thus tend to respond within weeks or months to changes in their environment, but stable and consistent communities of these organisms may take several years to form. Some reptiles, birds, and mammals seek out areas that provide seasonal refugia or that support their food and reproductive requirements (Bolduc and Afton 2008). Amphibians—notably frogs (Bunnell and Ciraolo 2010) and salamanders—depend on the seasonal availability of water for egg laying and larval survival and on the availability of insect larvae and adults as food sources (Surdick 2005). Other studies of macroinvertebrate populations in wetlands include work by Hayworth (2000) in cypress forests, Sharma and Rawat (2009) in the Central Himalayas, and Brazner et al. (2007) in the Great Lakes. Changes in hydrologic or water quality can change the balance among food sources and prey-predator relationships (Wilcox and Meeker 1992).

K1.3.6 Recovery of Wetlands after Major Hydrological Disturbance

Various studies have shown that wetland plant communities respond rapidly to changes in hydrology and that response to increased water depth or frequency typically is rapid. Different components of plant communities respond at different rates. While some herbaceous species may respond visibly in a matter of weeks and whole herbaceous communities may form in a few months, upwards of 20 years are needed to grow a new forest. Recovery rates will vary with the rate at which the hydrology is restored, and a sudden increase in water can, at least temporarily, add new stress (for example, Bacchus et al. 2000). What community develops also will be affected by other environmental factors, such as water quality, disturbance regime, and propagules (such as seed and fragments) available for re-establishment.

Landscape fragmentation, presence of nuisance species, and lack of habitat management reduce the chances for successful re-establishment.

K1.4 Water Level Change Criteria for Analysis of Indirect Wetland Impacts

Many wetland assessment methods have been developed that attempt to quantify the extent to which wetland functions have been altered. Generally, the assessment assigns some number to the wetland representing its condition pre-impact. Another number is then assigned representing its condition post-impact. The difference is assumed to be the effect of the impact. There are multiple approaches to how both initial condition and impact are to be measured. However, the assessment methodologies share basic assumptions, particularly that wetlands respond predictably to stressors and that alterations to the hydrologic regime are major causes of stress (USEPA 2004).

Among assessment methodologies that are relevant to assessment of slope wetlands, the Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Headwater Slope Wetlands on the South Carolina Coastal Plain (Noble et al. 2011), the North Carolina Wetland Assessment Method (North Carolina Wetland Functional Assessment Team 2010), and most rapid assessment methodologies (for example, Colorado's FACWet, Johnson 2011; or Florida's Uniform Mitigation Assessment Method [UMAM] 2004) share this assumption. To support permitting of the Haile Gold Mine Project, Ecological Resource Consultants, Inc. (ERC) developed a site-specific methodology that is consistent with the assumption that hydrological perturbations would affect wetland function (ERC 2012). However, the methodology is focused on the types of impacts caused by physical disturbances such as culverts, and is not directly applicable to changes in hydrologic regime that may occur due to dewatering.

Effects of changes in aquifer elevations can be evaluated in terms of current conditions and modeled drawdowns. As with site-specific condition assessments, there is an inherent assumption that wetland condition will be affected by changes in hydrologic regime. The remainder of this section focuses on aspects of wetland condition where the relationship between wetland physiography (such as shape and depth) and hydrologic regime (inundation depth, return intervals of various types of hydrologic events such as flood and drought, average depths, and characteristic inundation periods relative to location within the wetland) is reasonably well known. This approach allows for the potential to address changes in area as well as condition.

The effects of reduced seepage on the condition of slope wetlands can be evaluated in terms of affected area, likely condition during the stress period, and likelihood of recovery. It is appropriate to evaluate change in area in terms of the legal definition of wetlands and its associate hydrologic regimes. Likelihood of recovery can be assessed in terms of the degree of change experienced during the stress period, whether the changes caused by the stress are readily reversible, and the time period required for the wetland to return to a reasonable approximation of its pre-stressed self.

By definition, *wetlands* are areas "that are inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." This definition is found in the *Corps of Engineers Wetland Delineation Manual* (USACE 1987) and Regional Supplement (USACE 2010) and was used in the wetland delineations on the Project site.

Based on the *Corps of Engineers Wetland Delineation Manual* (USACE 1987), an area has wetland hydrology if it is inundated or saturated to the surface continuously for at least 5 percent of the growing season in most years. The delineated wetland line is the field delineator's best estimate of occurrence of this hydrology; thus, the delineation (and the elevations along the delineation line) is an estimate of where this hydrology occurs. Hence, if a change in groundwater regime reduces this elevation, there will be a corresponding decrease in the acreage of jurisdictional wetlands. The area that no longer meets requirements for inundation and saturation is effectively lost and will remain lost unless hydrology is restored.

Any area that is internal to the wetland and deeper than the edge (greater than 0 depth relative to the edge) would have a longer period of saturation or inundation (a longer elevation-specific hydroperiod) than the edge. Depending on the extent to which the wetland is dewatered, these deeper areas could remain wetland, remain unchanged, or be altered to an extent that the functions and values provided by these areas may be changed or lost. For example, a reduction in water levels that changes the system from having surface water being present long enough to support amphibian reproduction to one where amphibians cannot reproduce would eliminate the system as amphibian breeding habitat.

The nature of the changes in function and the relationships of the wetland to surrounding habitats largely determine whether specific functions will be restored if the hydrology is restored. For example, the ability of amphibians to recolonize after hydrology is restored would determine whether the wetland ultimately would recover its function as amphibian breeding habitat. The latter type of analysis depends on specific wetland characteristics and even individual species with a resulting need to generalize in order to make practicable judgments on the likely degree and duration of impacts.

The magnitude and duration of hydrologic events can be used to define the effects of high and low water events and event duration (Nash and Graves 1993; Johnson et al. 2011) on individual species. For example, an upland tree that successfully establishes in a wetland during an extended drought likely would be killed by a post-drought, high water level that subjects the roots of the tree to anaerobic conditions for a sufficient duration to kill it. The return interval for such events (both drought and flood) defines the elevation where the return interval of lethal, high water events recurs frequently enough to prevent permanent establishment of upland plant populations within the wetland boundary. The return interval typically is expressed in terms of years or sometime in terms of periodicity.

This concept is overly complex and intractable in terms of data requirements if applied at the level of individual species. However, while species have individual requirements, a number of commonalities to groups of species can be used to extend this concept to a plant community level, which then becomes a feasible way to assess the likely effects of hydrological changes on the wetland as a whole. Various aspects of determining needed depths, durations, and return intervals have been quantified and are suitable to use with limited data (for instance, see Epting 2007; Neubauer et al. 2008; Haag and Lee 2006). The following paragraphs describe some of the better documented relationships between wetlands, especially vegetation and soils and depths, and return intervals.

- **Upland Trees and Shrubs –** As a class, upland species lack needed root adaptations to handle anaerobic conditions (Kozlowski 1997; Sorrell et al. 2000). Upland species may colonize wetlands during periods of drought, but will be eliminated during periods of high water that last long enough to cause root mortality from anaerobic conditions. Because some upland species can survive inundation during the dormant season, periodic growing season saturation or inundation with a duration of several weeks or more is required to eliminate them. The lethal inundation event frequency needs to be frequent enough to eliminate trees that colonized during drought. A growing season flood duration on the order of 6–8 weeks is likely adequate to kill most upland species (Kabrick et al. 2007). This frequency may be on the order of 30–50 years (Neubauer et al. 2008).

- **Wetland Trees and Shrubs –** Woody plants require non-inundated conditions in which to sprout and grow to an adequate height in order to not be flooded over the tops of the young saplings. This implies occurrence of dry conditions on an adequately frequent basis for reproduction to occur. The interval between dry events may be long (for example, for cypress or swamp tupelo), but the need is documented. Conversely, reductions in water depths and creation of lengthy dry periods at elevations that were formerly too wet for establishment has been documented to result in colonization of wood plants into areas that were formerly marsh. Unlike upland plants that are killed by return of anaerobic conditions, if these trees are of adequate size when flooding returns, they may continue to live (some, such as cypress, may develop very tall buttresses). An extended period of inundation with a return interval of 7–10 years or less is required to prevent downward shifting of wetland trees and shrubs, and thus to retain marshes as marshes.

  Maintenance of soil moisture is important for growth and survival during drought periods. Restoration to conditions where the wetlands are relatively moist, even during droughts, may be critical for long term ecosystem function (Conner et al. 2011); but durations and frequencies of drought tolerance in relevant types of wetland systems are not well studied.

- **Persistent Species –** A number of woody invasive species are wetland adapted and can invade wetlands during dry periods, as described above. Most appear to be associated with seepage conditions or relatively shallow parts of wetlands, and many are fast growing. These include some pines, including loblolly and slash pines; some species associated with the term “bay,” including sweet-bay (*Magnolia virginiana*) and loblolly bay (*Gordinia lasianthus*); dahoon holly (*Ilex cassine*); and some Ericaceous shrubs. It also includes species such as Chinese tallow, Chinese privet, multiflora rose, and Japanese knotweed. These are non-native invasives that can become problematic during periods of dryness and persist when the normal hydrology returns. Lengths of inundation required to eliminate these species have been documented, but with slope wetlands, adequate inundation for elimination may not occur.
- **Herbaceous Seepage Species –** The wetlands on the Project site have limited groundcover, but a variety of ferns, including cinnamon fern (*Osmunda cinnamomea*) and netted chain fern (*Woodwardia aeriolata*), were frequently documented. Sphagnum moss also was documented. None of these species are associated with significant inundation; all are associated with seepage. If there is an absence of seepage for an extended period, lack of reproduction and gradual disappearance are anticipated.
- **Deep Water Herbaceous Species –** Most species that occur in marshes with constant or near-constant inundation lack adaptations to dryer conditions although most have the potential to survive limited periods of natural drought. Some are known to require subsurface moisture to persist during droughts; however, data on persistence are limited. Some have seed banks or root structures that allow them to come back quickly after droughts, some do not. In at least some environments, species such as pickerelweed (*Pontederia cordata*) appear to disappear and are replaced by more drought-adapted species such as maindencane (*Panicum hemitomon*). Inundation requirements for bulrush (*Scirpus cyperinus*), which was reported for multiple locations on the Project site, would suggest that some of the wetlands lower in the valleys have long hydroperiods.
- **Fast-Growing Species –** A number of herbaceous species appear in wetlands during dry periods and disappear rapidly on the return of hydrated conditions. Some of these are short lived, for example dog fennel (*Eupatorium capillifolium*) and fireweed (*Erechtities hiericfolia*). Their appearance is a normal part of the drought/flood cycle. However, becoming a permanent groundcover is not. These species are found either in light shade or in open areas that are at least temporarily dry. A return interval of inundation (saturation is not adequate) on the order of once every 2–3 years is needed to prevent dominance. Other invasive species such as some barnyard grasses (*Echinochloa* sp.) (Lopez-Rosas and Moreno-Casasola 2011) and *Phragmites* (the non-native variant) can take advantage of similar

settings, but like the persistent species of trees, can become problematic if dry-to-moist short hydroperiod conditions persist.

- **Pathogenic Root Fungi –** Upland trees are strongly associated with symbiotic and pathogenic relationships with fungi. Wetland trees are not, as these types of fungi are believed to require aerated conditions to spread and persist (Keddy 2000). Root and xylem diseases have been associated with persistent dry or very short hydroperiods (an estimated 5 percent or less of the growing season, meaning upland conditions). While very little data are available, it appears (based on data from dewatered wetlands in Florida [Bacchus 2000 as cited in Porter and Porter 2002]) that these conditions would need to persist for 3–4 years (longer than the typical drought) for the fungi to become problematic. Once present, trees may experience reduced growth rates, thin crowns, and mortality due to loss of roots coupled with increased risk of blowdowns because of the reduced support system.
- **Change in Soil Structure –** Relatively little research has been done on wetland soils other than organic soils. Multiple studies have been done on organic soils, and inundation or saturation to the surface of at least 50 percent or more of the growing season at least one of every two years appears necessary to maintain a balance between oxidation (which occurs when dry) and accretion (which occurs when wet). This number is variable and depends on the length of inundation, frequency of inundation, temperature (Stephens and Stewart 1977; Shih et al. 1998), amount of available vegetation for decomposition, vegetation composition and fertilization (Hooijer et al. 2012), depth to water (Stephens and Stewart 1977; Hooijer et al. 2012), and other factors (Reddy et al. 2006). Compaction of non-organic soils has been associated with dryness as well as with loss of hydric indicators. Other changes can occur simultaneously, including changes in nutrient availability (usually as a function of change in pH) and other factors. Organic soils are not the norm for the type of slope wetlands found at the Project site (Noble et al. 2011; SCDNR undated); therefore, a water regime of less than 50 percent of the growing season being inundated appears appropriate.
- **Fire –** Any wetland that is dry has increased risk of fire. Fire is a natural feature of Sandhills environments and is expected. A wetland in a gully-like valley is somewhat protected from fire, but if the wetland is dry, humidity is low, and/or winds blow fire toward a slope wetland, it could burn (for examples, see Mortellaro et al. 1995; Bendix and Cowell 2009). Because most of the trees common to slope wetlands have low fire tolerance, the vegetation may have difficulty recovering after fire.
- **Precipitation –** Precipitation is the driver for all major sources of water available to slope wetlands in Sandhills regions. Any effects of groundwater withdrawals are likely to be associated with intensification of drawdown effects in wetlands. If withdrawals increase the head difference between the CPS and saprolite aquifer relative to the bedrock aquifer, more precipitation will go to recharge and less will be available for seepage. Drought is likely to further reduce water available for seepage into the wetlands. In Florida, this combination has been shown to cause rapid deleterious change to wetlands on public water supply well fields. On the flip side, when induced recharge is removed, the water table mound has been shown to rebound rapidly under sandy hill slopes, and seepage is known to return quickly (Metz 2011). The recovery period predicted for the Project site is much longer (Newfields 2013), but the actual recovery time may vary depending on the degree of drawdown and variation in geology within the Project site.
- **Loss of Key Animal Species Including Amphibians and Crayfish –** Many wetland animals have rigid requirements for the presence of water. Needs vary by species. Expressed in terms of hydroperiod, standing water is a requirement for survival of individuals (most fish) or for reproduction (amphibians and many insects). These have not been included in this list of inundation requirements, as most are associated with streams, which have been analyzed separately. But it should be recognized that changes to the wetlands will affect aquatic habitats, and aquatic and semiaquatic animals frequently rely upon wetlands for parts of their life cycles.

- **Loss of Seed Bank and Seed Dispersal Changes –** Many species associated with moving water rely upon water for dispersal. Dispersal is not only by seed but also by fragments of plants (rhizomes, branches). Some plants time seed dispersal to coincide with flooding and the occurrence of suitable moisture conditions for germination and establishment (see Friedman and Auble 2000 for review). Maintenance of periodic pulses of water is needed on scales varying from 1–2 years to decades.
- **Changes In Erosion Potential –** Changes in both hydrology and local land use can affect erosion of the wetland and deposition of non-wetland materials into the wetland (Friedman and Lee 2002). To the extent that the latter exists, the depth of the wetlands could be reduced, and invasives such as ribbon grass (*Phalaris arundineacea*) could become established (Zedler and Kercher 2004). The extent to which this may occur is likely dependent on development of appropriate best management practices and their implementation.
- **Evaluation of Drawdown Effects –** For the purpose of evaluation, the wetlands have been assumed to be driven by a combination of upward piezometric gradients from groundwater in the surficial (unconfined) aquifer system, direct downslope seepage from water mounded within hill slopes, downstream flows (to the extent that they exist), and rainfall. The systems themselves are assumed to be in small headslope valleys that may have 0- or 3rd-order streams. Based on LiDAR, the wetlands are typically shallow, with depths on the order of 1–2 feet, and are underlain by saprolite or CPS. These are generally seepage systems and have enough groundwater support that they are generally discharge systems. Although not documented during the relatively brief period for which monitoring data are available, some shallow downward seepage (into the saprolite) may occur. Vegetation is mostly wetland forest, but some of the higher-order systems have marshy centers and are likely to receive some water from farther upstream wetlands and lateral seepage from the streams.

The criteria discussed above are summarized in Table K1-1. All effects are based on actual water levels within wetlands. Changes in groundwater hydrology may or may not result in changes to the wetland hydrology.

The extent to which the changes described above would occur would vary, based on a number of factors. If a hydrologic stress is of limited duration, weather conditions within the impact period may determine how long the stress occurs or even if it occurs. An extended rainy period could result in the anticipated impacts not occurring. Conversely, an extended drought would worsen impacts.

Time of year is likewise important. Most vegetation grows slowly or not at all during winter. Wetlands as a class can better tolerate both flooding and drought when most vegetation is dormant (Kozlowski 1997). However, cold could be more problematic in dry wetlands, especially for species at the northern ends of their ranges. Water reduces both the extent and the rate of temperature change; therefore, both hot and cold temperatures become more extreme.

Above all, underlying geology is likely an important factor in how much of the potential drawdown stress is actually realized in a wetland. The relationship between in-wetland water levels and water levels in the supporting aquifer system is discussed below.

K1.5 Aquifer Drawdown and Anticipated Response in Wetlands

The effects of hydrologic change in wetlands are well described and documented, and the groundwater model (Cardno ENTRIX 2013) predicts expected changes in groundwater levels due to pit depressurization and groundwater lowering. Together, these pieces of information can be used to predict hydrologic regime response in wetlands. However, the actual response of water levels in the wetlands as related to aquifer level drawdowns can be complex, and one would not expect the relationship to be one-to-one or the same over the entire Project site.

Many factors affect the amount of hydrologic change that may actually happen in wetlands; these include topographic position, wetland physiognomy, and site hydrology. The effects of dewatering in the bedrock aquifer were assessed in the groundwater model (Cardno ENTRIX 2013), but the groundwater model cannot precisely predict the wetland groundwater regime because of factors such as local variations in topography, surficial geology, and aquifer characteristics. In addition, post-mining topographic and land use changes that are not fully reflected in the model would affect the extent to which the water table in specific wetland areas might respond and rebound to pre-mining conditions.

This section presents some of the factors that can affect the local wetland hydrologic response to general groundwater lowering, pointing out the variability in response, and the types of wetland areas that may be more or less responsive to groundwater lowering.

Table K1-1 Anticipated Changes in Wetlands Based on Levels of Drawdown

Water Level Change within Wetland	Description of Anticipated Change
0–1 feet of drawdown	No change in wetland area or condition.
	Rationale: Models predict general conditions and (as a class) the type of model has enough spatial uncertainty and estimation inaccuracy that 1 foot is the minimum possible feasible prediction of "no drawdown."
1–2 feet of drawdown	Some change in area, but saturation or shallow inundation would be maintained in the center of the wetland.
	Rationale: Most of the smaller slope wetlands and all of the wetlands at the uppermost topographic positions in the drainages are less than 2 feet deep. Wetland conditions would be maintained in at least the wetland "core."
	Effects: Minor but measurable change in area. Some in-wetland colonization of upland species. Potential for invasion by adaptive nuisance species. Potential loss of species that require saturation for survival, such as sphagnum, cinnamon fern, sensitive fern, and netted chain fern. Shifts in proportion of wetland hydrated and/or shorter period of hydration. Soil fungi with pathogenic relationships to woody species may become established (can ultimately lead to tree loss). Potential for issues with wetland-dependent species if accompanied by drought. In wetlands with open areas, obligate species may disappear. Potential for fire, especially if combined with drought. Inundation may be inadequate for amphibians to successfully reproduce.

Table K1-1 Anticipated Changes in Wetlands Based on Levels of Drawdown (Continued)

Water Level Change within Wetland	Description of Anticipated Change
2–4 feet of drawdown	Substantial change throughout the wetland.
	Rationale: The entire wetland likely would be dry except during periods of extremely high rainfall.
	Effects: Shallower wetlands would be dry at all times. Deeper wetlands may have small areas of hydrated soils during rainy periods, but the time period of inundation would be reduced. Loss of wetland species. Potential for entire wetland to become non-jurisdictional. Loss of species such as crayfish; the duration would determine whether they could return prior to rehydration. Potential direct mortality of trees, especially with occasional floods. Loss of obligates even without drought. Potential for fire, even without drought. Loss of any organic soils is anticipated. Wetland likely would not recover species composition during the occasional rainy year. If persistent, loss of seed bank. Wildlife that use wetlands as refugia (summer or winter) may have issues. Possible erosion potential when it does rain.
4 feet or more of drawdown	Near complete loss of wetland function.
	Rationale: The entire wetland would be persistently dry.
	Effects: Wetland would be persistently dry. Loss of all jurisdictional area. Loss of wetland species. Loss of any animal species that requires saturation or standing water to complete its life cycle. Change in fire regime. Loss of organic soils. Wetland likely would not have the same plant community when hydrology is restored. Loss of seed bank. Wildlife that use wetlands as refugia (summer or winter) may have issues. Erosion potential when it does rain.

K1.5.1 The Surficial Aquifer System

The Groundwater Modeling Summary Report (Cardno ENTRIX 2013) documents varying degrees of conductivity in the various layers of the aquifer system. This technical memorandum focuses on the two layers that directly interact with the wetland systems: the CPS and the saprolite. For purposes of convenience, when referenced together, the groundwater in these units is referred to as the “surficial aquifer system.”

The two components to the surficial system vary in terms of how much water is supplied to a wetland, which wetland is affected and the frequency and duration of the water supply. In general, the CPS has greater horizontal and vertical conductivity than the underlying saprolite. Overall, the uplands are a recharge system. Head differences between the CPS and the saprolite, and local variation in the conductivity of both, will determine how much water infiltrates downward from the CPS into the saprolite. Overall, however, the greater conductivity within the CPS suggests that much of the water from the CPS has the potential to flow laterally and downward within the CPS toward nearby wetlands. Gravity, in combination with mounding from rainwater infiltration, accounts for the movement of the water in the surficial aquifer system (Cardno ENTRIX 2013).

Water from CPS and saprolite provides base flow for both wetlands and streams. Vertical infiltration from the CPS provides the predominance of the base flow. In general, lateral conductivities in the bedrock and saprolite appear are lower than vertical conductivities (Cardno ENTRIX 2013). This suggests that impacts due to withdrawals in the bedrock aquifer will be greatest close to withdrawal locations and will drop off rapidly with distance.

K1.5.2 Analysis of Water Levels in and near Wetlands at the Project Site

Wetlands may receive water, from the CPS, from the saprolite, or from both sources. As part of the groundwater hydrologic investigations performed by Haile Gold Mine, Inc. (Newfields 2013), four locations near wetlands were monitored with wells and nested piezometers. Water level data from these four settings were used to evaluate how wetlands within the Project boundary receive water and the potential response to drawdowns that may occur. One of the four areas was located on the upper slope of a CPS hill, somewhat upslope from the highest elevation in a slope wetland. The other monitoring areas were located in more downslope locations and showed variations in the substrates in which the wells were installed. One of the monitoring areas was set entirely in saprolite; the other three areas were in areas of CPS overlying saprolite.

K1.5.2.1 Upper Haile Gold Mine Creek Headwaters Area 1

This well monitoring area was located near the upper headwaters of Haile Gold Mine Creek (Reach P); it is represented by a groundwater monitoring site with nested wells in a shallow depressional feature (non-jurisdictional wetland) near the top of a hill (PZ-11-1, PZ-11-2, PZ-11-3) (Figure K1-2). The elevations of water in the nested wells and in nearby well PZ-13-17 were used to assess the most likely source (CPS or saprolite) of water available to the most upslope portion of the wetland under existing conditions. The wells indicated that the water table was continuously at or below the natural land surface at the edge of the depression. The shallowest well (PZ-11-1), reported to be in CPS sands, was likely a measure of the maximum extent of mounding that might be available to feed the nearest jurisdictional slope wetland. PZ-13-17 is also located in CPS.

Based on topography, this system is describable as a toe slope wetland. In studies from similar settings, these have been shown to be variable based on sediments within the wetland and on temporal variations in seepage (Dobbs 2010). The topography and water levels in the wells suggest that this type system has a more lasting and more reliable source of water than the slope wetland at the top of its drainage, with spring months having reliable seepage inputs and dry summer months being more variable. Dobbs also suggested that some valley wetlands have the potential to get some water from the stream system. In similar settings, the relative amounts of water coming from seepage and saturation associated with the stream were found to be highly variable (Dobbs 2012).

PZ-11-2 and PZ-13-3 were screened in saprolite. Based on data supplied by Newfields (December 2013), the water level in the surficial PZ-11-1 well was approximately 3 feet below the surface within the depressional area and as much as 8 feet below the edge of the depression for much of the monitoring period. The water level in this well rose to above the surface of the borrow area to reach approximately 1.5 feet below the rim of the depression at its highest measured point in 2013 (measurements were not available after late May 2013). The water level was lower than the sensor (more than 8 feet below the edge of the depression) for approximately one-third of the monitored periods. Two wells described as CPS/saprolite were consistently lower than the water level in the CPS well and approximately 12–13 feet below the rim of the depression for approximately two-thirds of the monitored period. The relative elevations of water in the wells were consistent with these wells being in a recharge area, and consistent with the hydrology found in other shallow depressions in CPS sands in South Carolina (Pyzoha et al. 2008). Figure K1-3 shows groundwater elevations in Area 1 for PZ-11-1, PZ-11-2, and PZ-11-3.

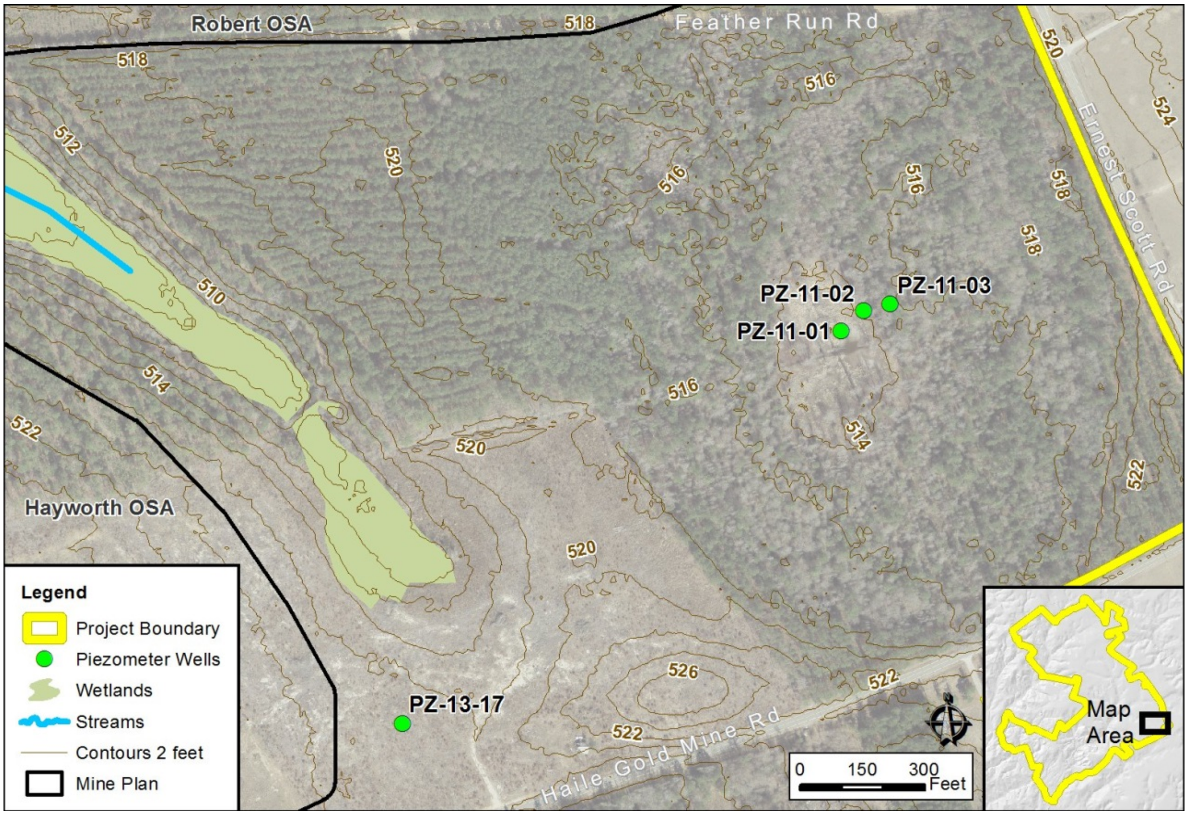

Figure K1-2 Area 1 showing location of nearby monitoring wells. PZ-11-2 and PZ-11-3 are screened in saprolite. PZ 11-1 and PZ 13-17 are screened in CPS. The delineated wetland is shown in green.

A headwater slope wetland adjacent to PZ-11-17 is shown in the left portion of Figure K1-2 and sits at an elevation of approximately 512–514 feet based on LiDAR. The water table elevations measured under the hill with the monitoring wells (PZ-11-1, PZ-11-2, PZ-11-3) were above 512 feet for approximately 15 percent of the monitoring period and above 514 feet for approximately 5 percent of the time. This is consistent with a short period of seepage at the upper end of the slope wetland, and suggests that the wetland edge may receive water from the uphill portion of the slope for a time period that closely matches what would be anticipated at a wetland jurisdiction line.

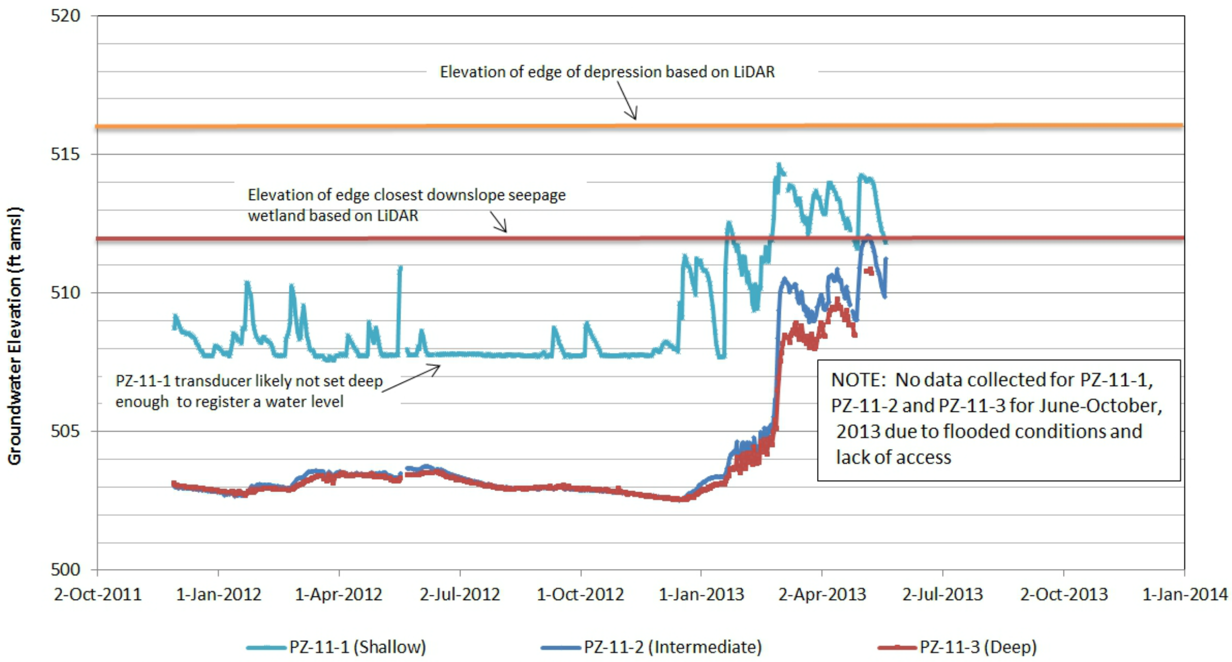

Figure K1-3 Water levels in Area 1 with nested wells PZ-11-1 (surficial sands), PZ-11-2 (CPS/saprolite screened 10-15 feet bgs), and PZ-11-3 (screened 25-30 feet bgs)

The water surface for the CPS/saprolite wells PZ-11-2, and PZ-11-3, beside the surficial PZ-11-1 well are lower than the water levels in the CPS wells and lower than the uppermost elevation of the jurisdictional line. Well PZ-13-17, which is very close to the slope wetland, is screened in the CPS and has water elevations consistently above the wetland edge, indicating that the CPS to the southeast is also a likely source of water for the wetland. Higher elevation sands to the south and southeast may control the uppermost wetland elevation in those directions. It also suggests that seepage is absent when the water level in the CPS sand drops below the jurisdiction line. It appears that water levels in the saprolite do not reach elevations likely to supply water to the wetland except during periods of high rainfall. It appears likely that gravity-driven horizontal water movement through the vadose zone and upper surficial aquifer system ("interflow" *sensu* Fetter [1994]; Subramanya [1994]) likely provide major water sources for the uppermost seepage areas in the wetland. Caution is required as the monitoring period was short and three of these wells are in a non-jurisdictional area, but it appears to indicate that the wetland begins at the uppermost elevation where there is adequate seepage to support a jurisdictional wetland.

The data also suggest that water levels in the CPS likely cannot be lowered much under this upper part of the wetland without causing a reduction in wetland area. These four wells suggest that lateral/downslope flows from the shallow sand aquifer are likely the major source of water for the upper slope wetland, but do not provide adequate evidence from which to conclude that the saprolite portion of the surficial aquifer system does not also supply water to the wetland. The water levels in the saprolite are high enough to supply water to the wetland at somewhat lower elevations.

K1.5.2.2 Upper Haile Gold Mine Creek Area 2

Area 2 occurs in headwater seepage wetlands directly adjacent to the upper portion of Haile Gold Mine Creek (Figure K1-4). The area represents headwater wetlands along a 2nd-order stream (Reach R) that are lower in elevation than Area 1. The wetland is broader and deeper than many of the wetlands on the Project site, and the topography east of the wetland is subdued. The hydrological monitoring suggests that these wells receive support from the surficial aquifer system, but that local geological and topographic variations may result in different water regimes within the wetlands. In each of the three wells, there was a shallow well in or adjacent to the wetland itself, typically shallow and in a deposit that may have been reworked by water. Two of the wells are described as being in saprolite or CPS, depending on the site.

PZ-11-5 and PZ-11-6 are 15 and 30 feet deep, respectively. PZ 11-4 is in a somewhat clayey wetland deposit. The delineated wetland line is shown in green in Figure K1-4. This area is immediately downstream of Snowy Owl Road. Based on LiDAR, the wetland edge is between 502 and 504 feet bgs. The PZ-11-4 well in the wetland is well out in the wetland and at a land surface elevation substantially below the wetland edge elevation. The intermediate and deep wells are outside of the wetland on the valley side. The shallow well is in sand and the deeper wells are in layered mixtures of sand and saprolite. Water levels in both of the deeper wells (Figure K1-5) are above the elevations of water in the wetland well. The source of water for these wells is assumed to be deep seepage from beneath the hills near the wetland. There is no installed well that would measure contribution of any shallow, near surface, flow. It appears likely that “interflow” (*sensu* Fetter [1994]; Subramanya [1994]) provides major water sources for the wetland seepage areas.

Based on topography, this system is describable as a toe slope wetland. In studies from similar settings, these have been shown to be variable based on sediments within the wetland and on temporal variations in seepage (Dobbs 2010). The topography and water levels in the wells suggest that this type system has a more lasting and more reliable source of water than the slope wetland at the top of its drainage, with spring months having reliable seepage inputs and dry summer months being more variable. Dobbs also suggested that some valley wetlands have the potential to get some water from the stream system. In similar settings, the relative amounts of water coming from seepage and saturation associated with the stream were found to be highly variable (Dobbs 2012).

Another set of nested wells (PZ-11-10, PZ-11-11, and PZ-11-12) were installed in a similar topographic setting to Area 2 but were situated in the Camp Branch Creek subwatershed. The piezometers were installed within and adjacent to a wetland area upslope of Reach QQQ, which is one of the headwater tributaries of Camp Branch Creek. No graphics are provided for this area as the well logs and hydrologic data are consistent with Area 2 (Upper Haile Gold Mine Creek). The area represents a smaller seepage system and likely gets considerable water from the CPS.

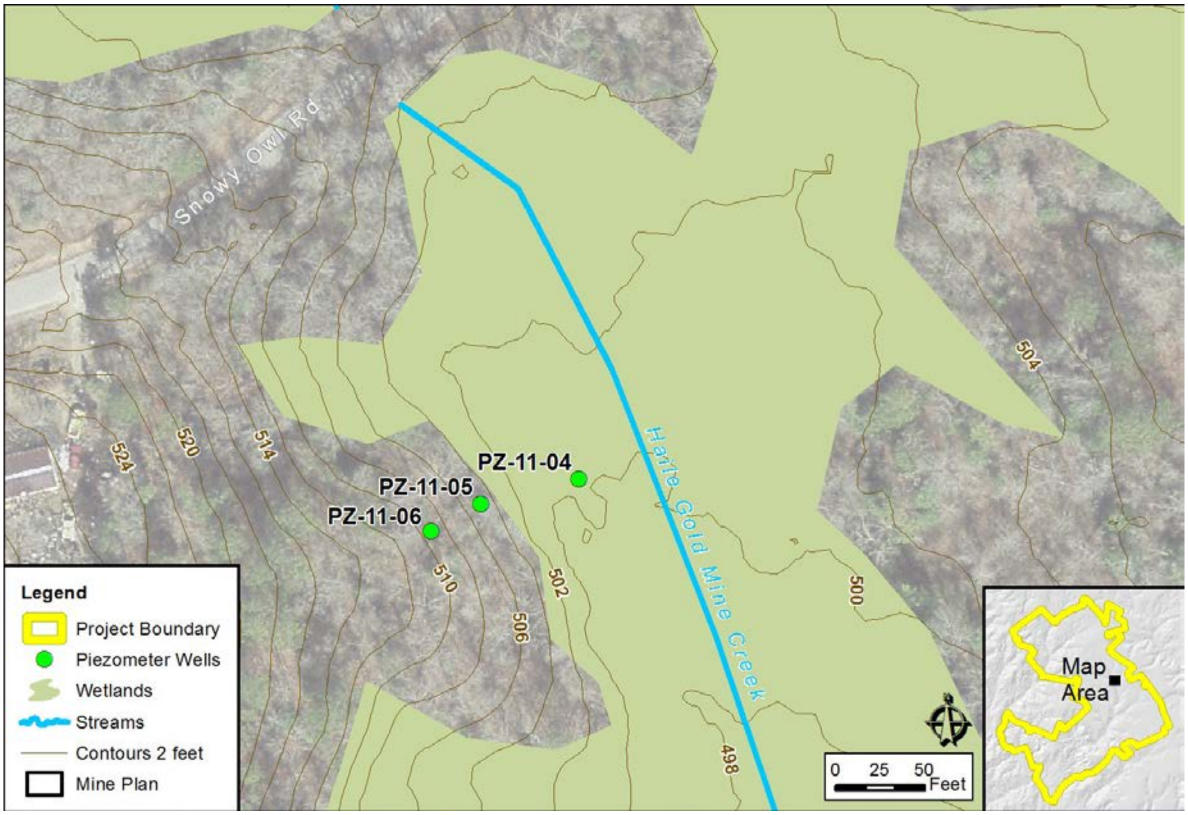

Figure K1-4 Delineated wetland in Area 2 along an upper reach of Haile Gold Mine Creek showing the location of nearby monitoring wells.

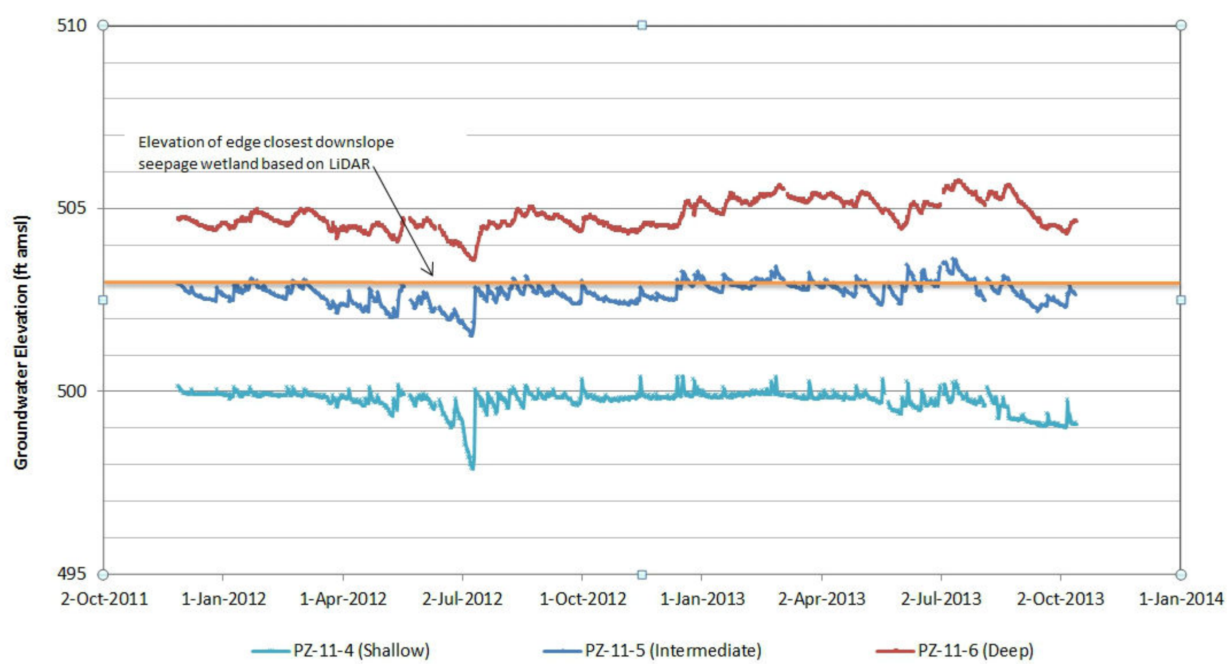

Figure K1-5 Water levels in nested wells PZ-11-4 (reworked materials inside of the wetland), PZ-11-5 (screened 10-15 feet bgs), and PZ-11-6 (screened 25-30 feet bgs).

Lower Haile Gold Mine Creek Area 3

A third topographic and geologic setting is represented by the PZ-11-7, PZ-11-8, and PZ-11-9 set of wells (Figure K1-6). These wells are in a narrow valley abutting Reach G, which is a headwater wetland tributary that drains into lower Haile Gold Mine Creek. As such, they represent headwater wetlands that are lower in elevation than Areas 1 and 2. All the wells are in saprolite, and all wells are outside of the established wetland jurisdiction boundary.

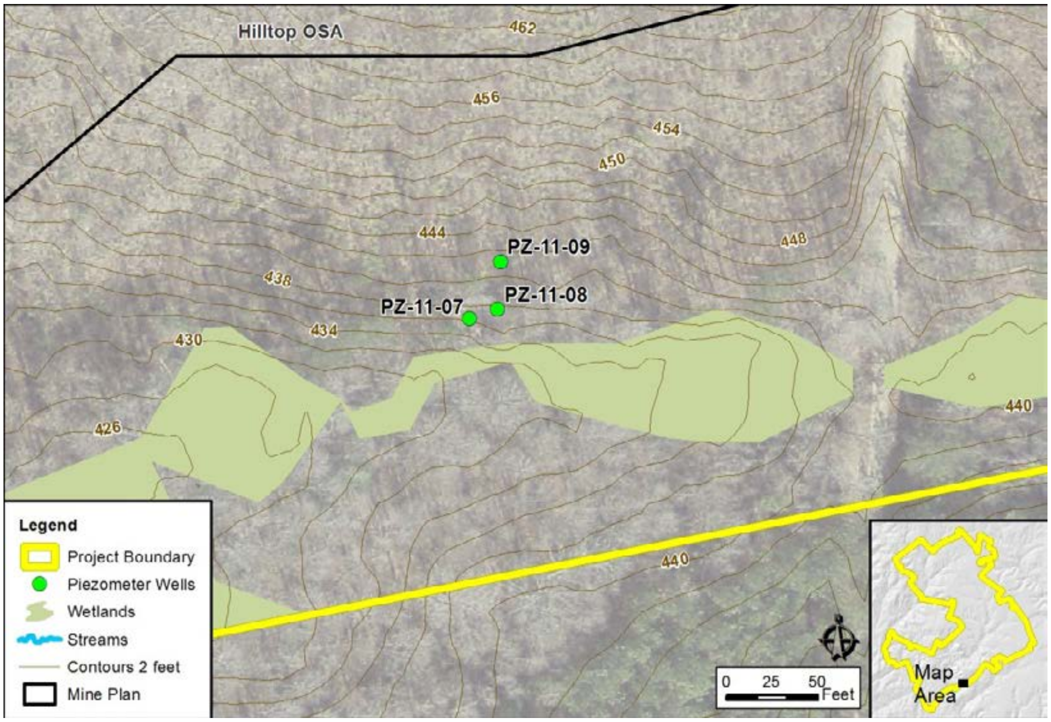

Figure K1-6 Delineated wetland in Area 3 along a first -order intermittent drainage with monitoring wells PZ-11-7, PZ-11-8, and PZ-11-9.

The LiDAR map does not show any of the wells to be within the jurisdictional wetland (green line). However, the shallow well may be indicating the presence of shallow groundwater flows just outside of the wetland. The water levels in wells at this wetland appear to fluctuate consistently but with only slight differences (about 1 foot) in water elevation between the wells (Figure K1-7). Water levels were consistently below ground during the monitoring period at the shallow well. The estimated elevation of the wetland edge based on LiDAR is approximately 432 feet, which was attained briefly during the monitoring period.

The observed fluctuation pattern (Figure K1-7) shows brief abrupt rises in water levels after precipitation, suggesting a flashy system that may have a fairly direct dependence on rainfall for meeting its hydration requirements. Assuming that the LiDAR is adequately accurate, it appears that the delineated wetland only marginally meets the USACE hydrological requirements for being jurisdictional. The lower conductivities in saprolite are a likely factor in the wetland's water budget.

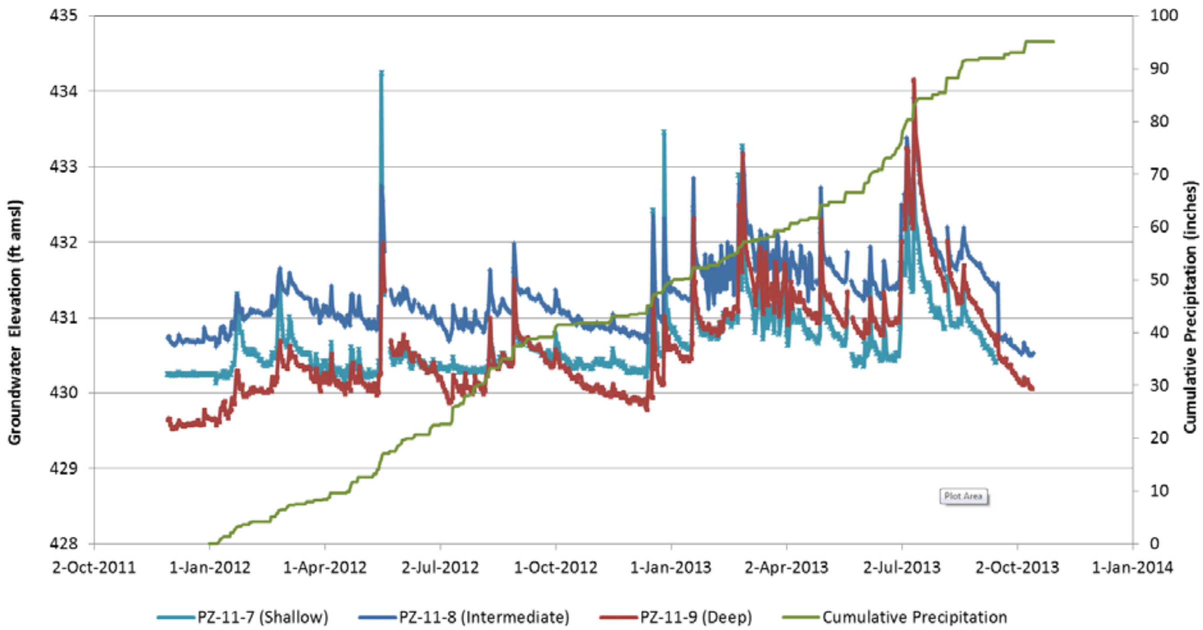

Figure K1-7 Area 3 water levels in nested wells PZ-11-7 (reworked materials inside of the wetland), PZ-11-8 (screened 10–15 feet bgs), and PZ-11-9 (screened 25–30 feet bgs).

Because of lower conductivity in the saprolite, less water likely infiltrates into the ground from rainfall than occurs where there is a thick layer of sand above the saprolite. The low conductivities in the horizontal dimension relative to the vertical suggest that less still will flow horizontally within the saprolite to be available to supply seepage support to wetlands. The conductivity characteristics also suggest that the seepage component available to wetlands may be susceptible to drawdown.

Figures K1-8 through K1-10 depict the three wetland settings that were discussed: a slope wetland near the upper limit of seepage, a slope wetland in a valley and with at least some of its water likely originating from CPS, and a slope wetland in a valley with saprolite providing the base flow into the wetland.

A wetland in a setting like that shown in Figure K1-8 likely interacts solely with the CPS in its most upslope portions. Lower in the valley, the saprolite likely intersects with the valley floor. Based on hydrologic records and known behavior of water movement in sands overlaying less permeable materials, it is likely that a major component of the wetland water budget is interflow. It is probable that overland flow is only a minor part of the wetland water budget.

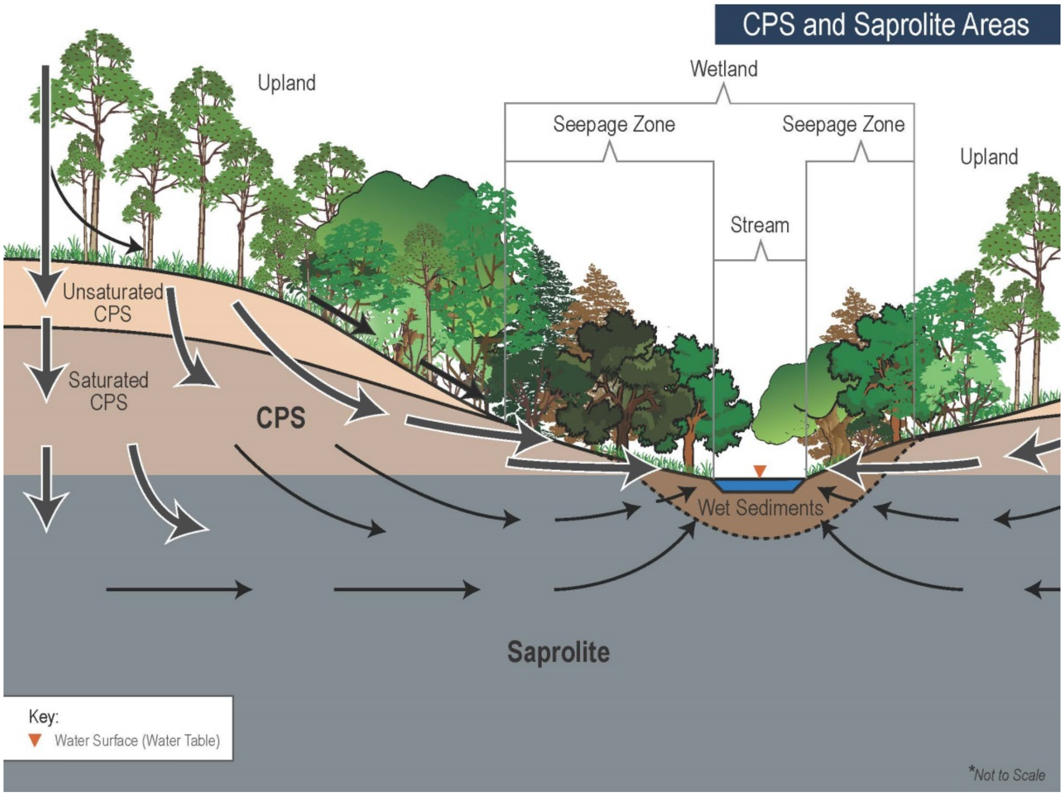

Figure K1-8 Conceptual Illustration of Water Movement into Slope Wetlands in an Area Where CPS and Saprolite both Likely Provide Water to the Wetland

The data suggest that that discharge from the saprolite is likely a significant component of the water budget once the elevation in the "floor" of the wetland is lower than the elevation of the saprolite. Based on vertical and horizontal conductivities in the CPS and saprolite, it appears likely that wetlands in this type of setting would continue to get most of their historical interflow and overland flow, and that there would likely be less water available in the saprolite for discharge if the modeled drawdown in the saprolite layer of the model is realized. The lower conductivity in the saprolite combined with hill slopes just above the CPS/saprolite interface suggest that a wetland in this type of setting might experience less loss of water due to groundwater withdrawals than one that is entirely in a saprolite setting. This setting is likely to be fairly common in the northern and eastern portions of the Project site.

The wetland in Figure K1-9 is in a largely CPS setting. Some saprolite or clay layers may be present, as shown in the well logs for the Haile Gold Mine Creek Project site, but enough CPS is present to suspect that CPS is the source for most water. Haile Gold Mine Creek and the Upper Camp Branch Creek where it borders the Duckwood TSF are examples of wetlands in this setting.

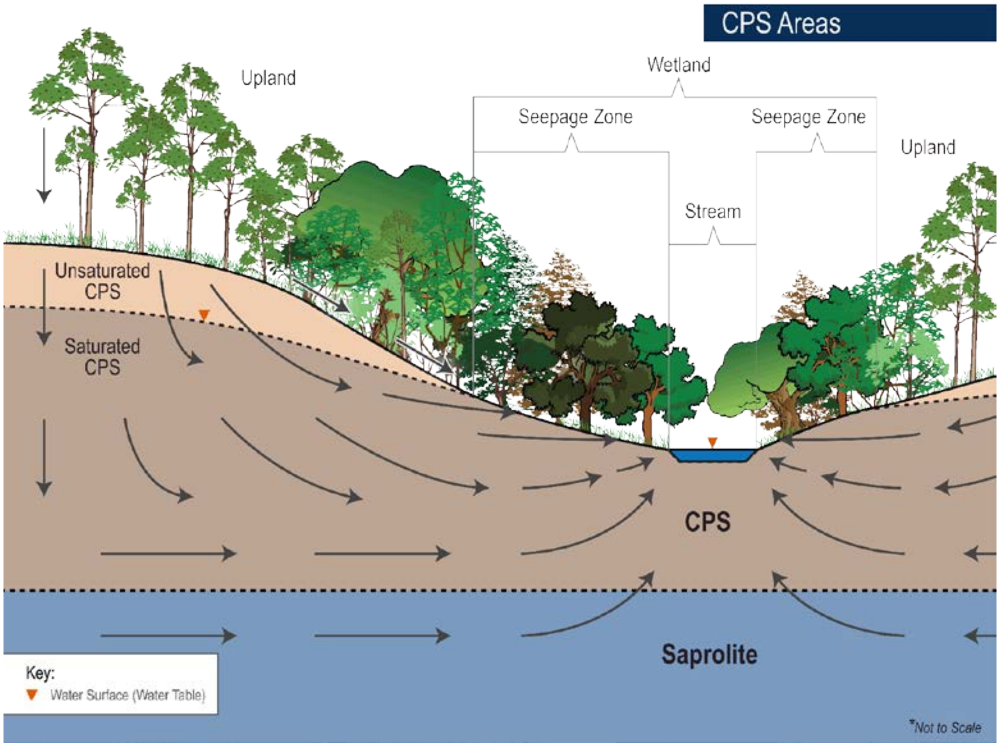

Figure K1-9 Conceptual Illustration of Water Movement into Slope Wetlands in a Coastal Plain Sand (CPS) Setting

The wetland in Figure K1-10 is representative of a saprolite-dominated setting. There may be minimal or no CPS deposits on the hills. The general flow pattern is the same but, based on the one monitored site, this wetland may get much of its water in quick periods of runoff after rainfall and little from interflow or groundwater discharge. It is likely that runoff supplies a more major portion of the water budget than in the previous settings, as infiltration into the saprolite is likely less than infiltration into sand. When infiltration occurs, there is less likely to be substantial horizontal gravity-driven flow (interflow). As in the wetland shown with its "floor" in the saprolite (Figure K1-8), some discharge from the saprolite is anticipated. If groundwater is withdrawn at depth, it is probable that a substantial amount of the discharge may be lost from the water budget resulting in a wetland that is both dryer and more dependent on runoff. This scenario appears to be likely in the southern portion of the Project site and likely also occurs in the southern parts of Camp Branch Creek and near Champion Pit.

There is substantial topographic variation from place to place on the Project site. That variation is likely to play an important role in the amount of water table reduction that may be caused by groundwater withdrawals. Some parts of the Project site have higher hills with more volume in which water mounding can occur than others do. While the uppermost slope wetlands are likely at the uppermost elevation where seepage can occur in their basins, wetlands lower down in the valleys have increasingly larger reservoirs of water mounded above them, and more baseflow and interflow should be available. The water mounded under higher and larger hills may continue to provide seepage through the CPS, saprolite, and overland flow even if there is moderate reduction in the total elevation of the water mound above the wetland.

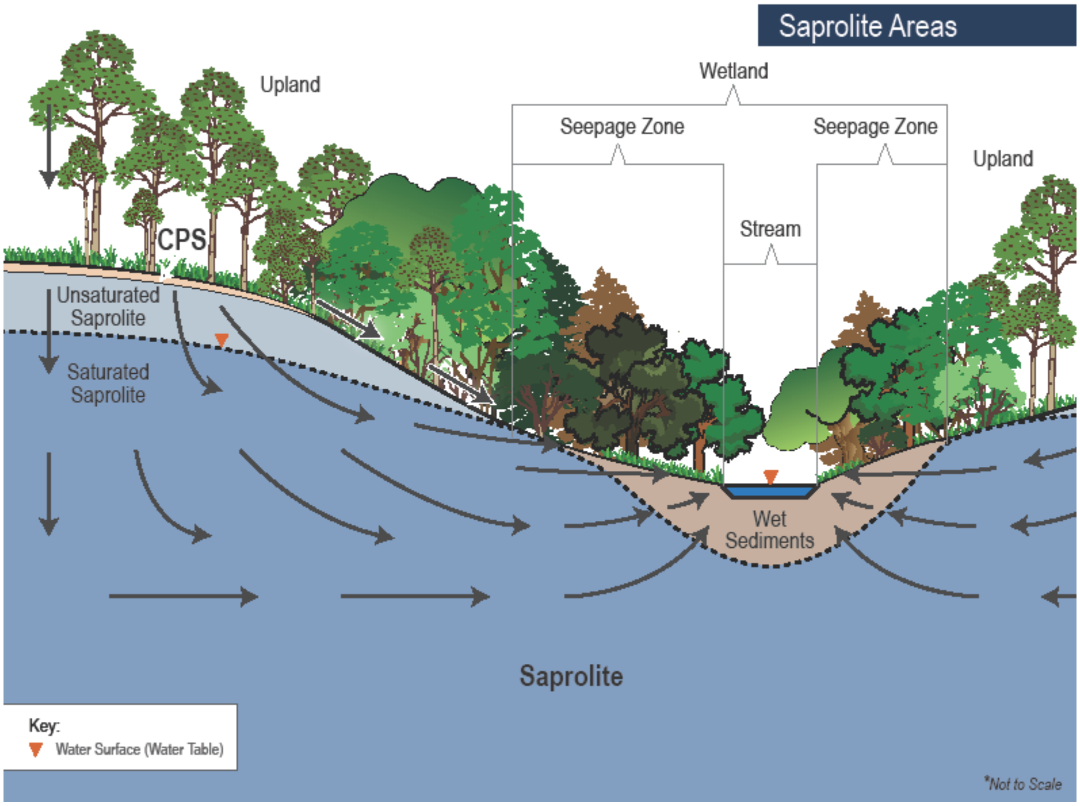

Figure K1-10 Conceptual Illustration of Water Movement into Slope Wetlands in a Saprolite Setting

There is considerable place-to-place variation in both vertical and horizontal connectivity in the CPS and saprolite. Both the degree of water table reduction due to groundwater withdrawal and potential long term effects likely will be influenced by topography prior to, during, and post-mining. Depths of borrow areas and where they lie topographically relative to wetlands will be important to how much they may affect the hydrology of those wetlands. Post-mining, the effects of mine dewatering gradually would decrease. However, effects due to changes in topography would result in permanent changes to wetland water regimes.

The groundwater model results show that the groundwater table reductions would vary in both intensity and location over the life of the mine (Figures K1-11 and K1-12). The model took into account both the quantity and location of the withdrawals over time and the differing horizontal and vertical conductivities in the aquifer system. Figures K1-11 and K1-12 provide estimated groundwater drawdowns for the life of the mine on an annual basis. While the increased head difference due to withdrawals between the CPS and saprolite should result in some additional water infiltrating downward from the CPS, the rate of infiltration likely will be limited by the lower conductivity of the saprolite. This suggests that where ample CPS overlies the saprolite, more water may be available for wetland support relative to what is available in saprolite-dominated areas. Overall, the extent to which the rainwater and water in the CPS infiltrates into the saprolite and underlying bedrock will be an important determinant of hydrologic change in the wetlands.

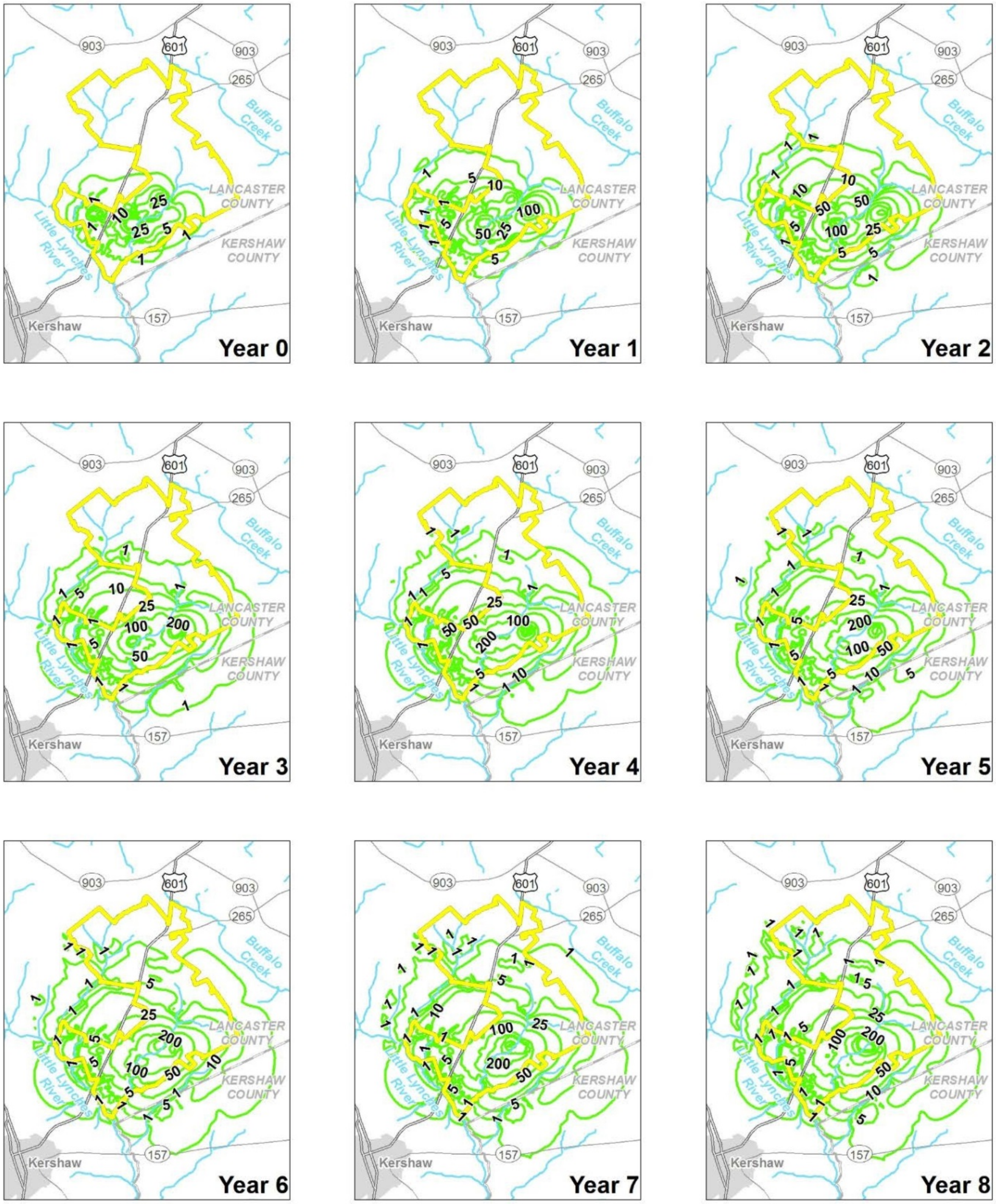

Figure K1-11 Areas of Groundwater Elevation Reduction to the Saprolite (Groundwater Model Layer 2) Part of the Surficial Aquifer System (Mine Years 0 through 8)

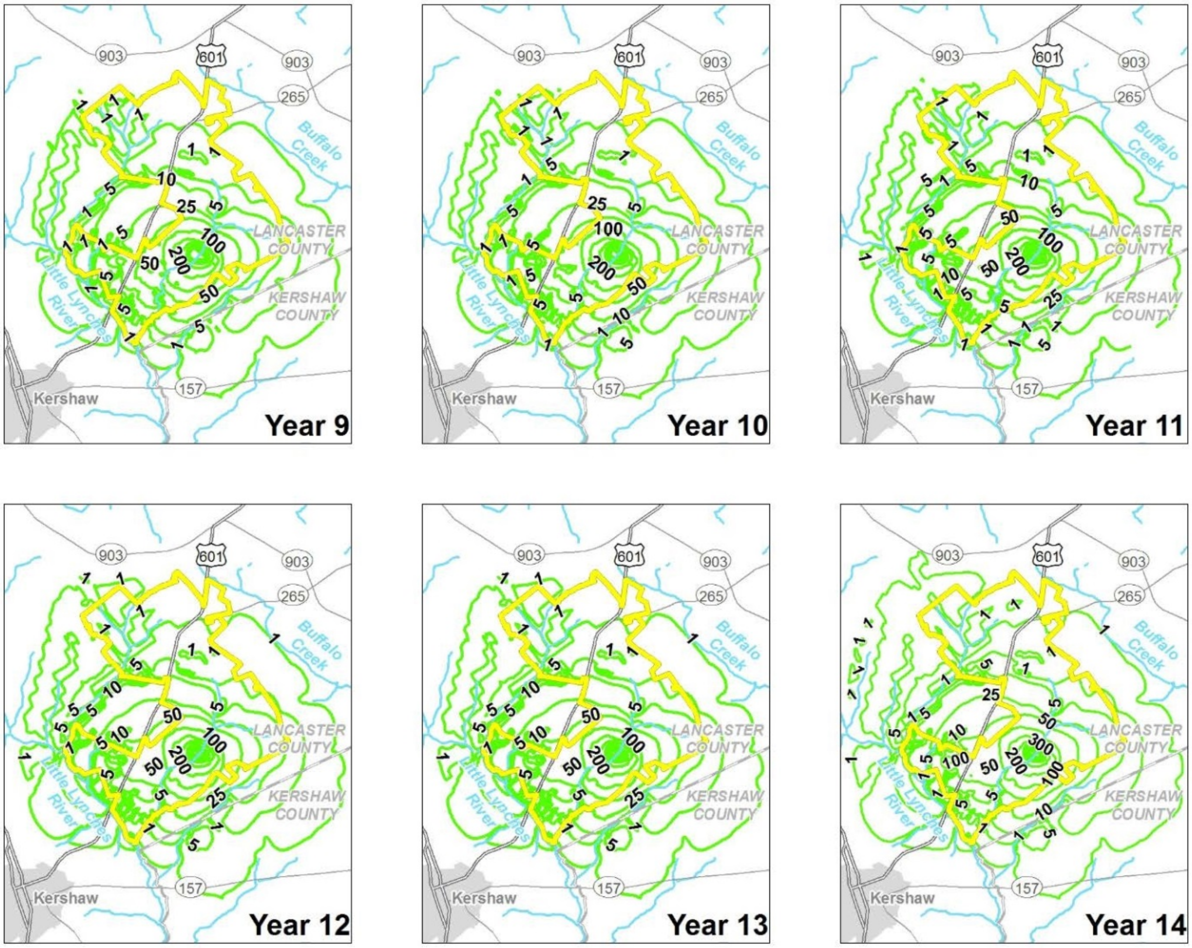

Figure K1-12 Areas of Groundwater Elevation Reduction to the Saprolite (Groundwater Model Layer 2) Part of the Aquifer System (Mine Years 9 through 14)

Both the area and the intensity of predicted groundwater drawdown build gradually over the life of the mine (Figure K1-11 and K1-12). The drawdown tends to be greatest near the withdrawal areas but drops off rapidly with distance, consistent with the low horizontal conductivities in the saprolite and bedrock aquifers. Most of the area that would experience the greatest drawdowns also would be directly affected by the mining and thus would be mitigated.

Figures K1-11 and K1-12 show the extent and degree of drawdown predicted by the groundwater model over the life of the mine. As noted above, however, the water source available to wetlands is locally variable, and actual reductions in water table levels in wetlands may vary considerably.

Because headwater wetlands exist on hill slopes and in low areas between hills, the amount of water received by these wetlands would likely vary spatially based on where the groundwater withdrawals are occurring. Some areas around the Project site are characterized by hills, with wetlands occupying small sloping valleys. The relative position of the wetlands relative to the top of the hill also likely would be a factor. Some of the headwaters slope wetlands have 20 feet or less of nearby topographic relief. The underlying water table mound lies below the land surface; consequently, potential groundwater mounding above these systems is less than the amount of mounding that would occur above a wetland lower down the valley.

The monitored Area 1 site and adjacent wetland lie near the 10-foot modeled drawdown contour (see Figure K1-12). Given the relatively limited extent of water table mounding above the wetland implied by the nearby wells, it appears that reductions affecting the lower water level in the shallow sand aquifer under the hill would affect the hydrology of the upper slope wetland in this type of setting. The degree to which the mounding in the CPS is affected likely would determine the magnitude of potential changes in interflow and water losses to the uppermost wetlands.

Wetlands on side slopes at lower elevations likely would respond and be more tolerant of water table change as the amount of adjacent hills, and consequently the magnitude of the water table mound, is greater. They also may lose the below ground interflow seepage from the upslope wetlands, as there may be less subsurface flow, and the amount of seepage from the slope would be less. However, the size of the water table mound and surficial groundwater available upslope of the wetlands would be greater and would have greater potential to support these lower elevation wetlands. What seems certain is that the wetland hydrology would be considerably reduced if the groundwater mound of adjacent hills were to be lowered to the extent that there was little or no groundwater mounding above the wetland edge elevation. This suggests that the maximum drawdown that could be tolerated without loss of wetland area would be somewhat less than the difference between the height of the adjacent hills and the upper edge of the wetlands.

Effects during mining and post-mining would be variable but at least partially predictable based not only on modeled drawdowns but also on topographic setting, topographic change, actions to minimize impacts, and topographic restoration post-mining. For example, it would appear that wetlands southwest of the Little Lynches River may be less likely to be affected given the same groundwater lowering (up to a point) than those on the northeast side, because their uppermost headwaters lie away from the area with the greatest surficial aquifer system drawdowns.

Wetlands in the northwestern-most part of the Project site appear to have the potential for topographic change to permanently reduce water available to support the uppermost wetlands in their headwaters. The hill slopes above the slope wetlands on Camp Branch Creek tributaries may experience 1–5 feet of drawdown during part, but not all, of the mining period, with the impact period being relatively short. However, topographic change also would result from borrow activities. The proposed borrow activities would remove most of the hill material above the uppermost wetlands, leaving no opportunity for a groundwater mound to exist in the post-mining environment. The anticipation is that wetland function and jurisdiction will be lost from the uppermost limits of the headwaters down to an elevation that allows for a groundwater mound to exist. The mined material will be CPS sand, with the post-mining hill top having much less sand and saprolite at or near the surface. Therefore, the drainage and seepage patterns likely would shift from something relatively similar to the pre-mining conditions represented by Area 1 to the pre-mining conditions represented by Area 3. Effects of topographic change are anticipated to decrease with decreasing elevation along the tributaries.

K1.6 Summary

This appendix was produced to provide support for the analysis of potential indirect impacts of groundwater lowering on wetlands at the Haile Gold Mine due to pit depressurization. Thresholds of in-wetland water level changes can be used as a general measure of wetland impact if the actual expected water level changes are presented. Because the relationships between aquifer drawdown and resultant wetland hydrology can be complex, the available information on measured wetlands water levels and nearby surficial aquifer levels at four areas within the Project site were evaluated to assess the likely responses and expected variability over the Project site. A number of factors were determined to be potentially important, including surficial geology, surficial aquifer characteristics, topography and localized groundwater mounding, post-mining topography, and other factors.

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APPENDIX K2

Summary of Direct Impacts on Waters of the United States

List of Tables

Table K2-1 Summary of Direct Stream Impacts

Stream ID	Order	Flow Regime	Cowardin	Impact (Linear Feet)	Mining Activity Area	Impact Type
Reach C	1st	Non-RPW	R4SB4C	1,576.84	Ramona OSA	Fill
Reach D	1st	Non-RPW	R4SB4C	3,532.55	Ramona OSA	Fill
Reach BBB	1st	Perennial	R2UB2H	450.67	Duckwood TSF	Fill
Reach DDD	1st	Perennial	R2UB2H	348.52	Duckwood TSF	Fill
Reach EEE	1st	Perennial	R2UB2H	2,419.18	Duckwood TSF	Fill
Reach S	1st	Perennial	R2UB2H	471.51	Plant Site Haul Road	Pipe
Reach CC	1st	Perennial	R2UB2H	320.71	Champion Pit	Fill
Reach T	1st	Perennial	R2UB2H	614.64	TSF Haul Road	Pipe
Reach M	1st	Perennial	R2UB2H	1,608.36	Pit Related Activities	Fill
Reach N	1st	Perennial	R2UB2H	241.59	Pit Related Activities	Fill
Reach Q	1st	Perennial	R2UB2H	269.17	James OSA Haul Road	Pipe
Reach P	1st	Perennial	R2UB2H	261.01	Roberts OSA Haul Road	Pipe
Reach N	1st	Perennial	R2UB2H	1,011.80	Johnny's OSA	Fill
Reach E	1st	Seasonal	R4SB4C	2,001.83	Ramona OSA	Fill
Reach L	1st	Seasonal	R4SB4C	877.40	601 OSA	Fill
Reach JJ	1st	Seasonal	R4SB4C	260.48	Champion Pit	Fill
Reach KK	1st	Seasonal	R4SB4C	219.26	Champion Pit	Fill
Reach L	1st	Seasonal	R4SB4C	547.29	Pit Related Activities	Fill
Reach AAA	2nd	Perennial	R2UB2H	571.29	Duckwood TSF	Fill
Reach AAA	2nd	Perennial	R2UB2H	167.89	Duckwood TSF	Fill
Reach AAA	2nd	Perennial	R2UB2H	707.91	Duckwood TSF	Fill
Reach AAA	2nd	Perennial	R2UB2H	1,548.69	Duckwood TSF	Fill
Reach OOO	2nd	Perennial	R2UB2H	277.96	Holly TSF Borrow Area Haul Road	Pipe
Reach J	2nd	Perennial	R2UB2H	1,564.74	Pit Related Activities	Fill
Reach SS	3rd	Perennial	R2UB2H	203.58	Hock TSF Borrow Area Haul Road	Pipe
Reach F	3rd	Perennial	R2UB2H	1,361.85	Pit Related Activities	Fill
Reach F	3rd	Perennial	R2UB2H	1,090.46	Pit Related Activities	Fill
Reach F	3rd	Perennial	R2UB2H	1,506.23	Pit Related Activities	Fill
Reach F	3rd	Perennial	R2UB2H	427.13	Detention Structure	Fill
			Total	26,460.54		

Table K2-2 Summary of Direct Wetland Impacts

Wetland ID	Cowardin	Acreage	Mine Activity Area	Impact Type
Wetland AAA	PEM1/POWHb	1.05	Duckwood TSF	Fill
Wetland EEE	PEM1C	0.17	Duckwood TSF	Fill
Wetland F	PEM1C	0.48	Pit Related Activities	Fill
Wetland F	PEM1C	0.28	Pit Related Activities	Fill
Wetland F	PEM1H	0.61	Pit Related Activities	Fill
Wetland F	PEM1Hh	3.13	Pit Related Activities	Fill
Wetland AAA	PFO1B	2.06	Duckwood TSF	Fill
Wetland AAA	PFO1B	4.91	Duckwood TSF	Fill
Wetland AAA	PFO1B	1.26	Duckwood TSF	Fill
Wetland AAA	PFO1B	0.28	Duckwood TSF	Fill
Wetland BBB	PFO1B	4.20	Duckwood TSF	Fill
Wetland DDD	PFO1B	2.34	Duckwood TSF	Fill
Wetland EEE	PFO1B	1.86	Duckwood TSF	Fill
Wetland QQQ	PFO1B	2.28	Duckwood TSF	Fill
Wetland S	PFO1B	1.02	Plant Site Haul Road	Fill
Wetland R	PFO1B	0	Plant Site Haul Road	Fill
Wetland F	PFO1B	0.76	Pit Related Activities	Fill
Wetland F	PFO1B	1.07	Pit Related Activities	Fill
Wetland F	PFO1B	1.06	Pit Related Activities	Fill
Wetland F	PFO1B	5.39	Pit Related Activities	Fill
Wetland F	PFO1B	0.74	Pit Related Activities	Fill
Wetland F	PFO1B	6.48	Pit Related Activities	Fill
Wetland F	PFO1B	2.77	Detention Structure	Fill
Wetland Q	PFO1B	1.45	James OSA Haul Road	Fill
Wetland P	PFO1B	1.13	Robert OSA Haul Road	Fill
Wetland F	PFO1B	1.38	Johnny's OSA	Fill
Wetland F	PFO1B	3.09	Johnny's OSA	Fill
Wetland N	PFO1B	1.03	Johnny's OSA	Fill
Wetland C	PFO1B	0.07	Ramona's OSA	Fill
Wetland CC	PFO1B	0.33	Champion Pit	Fill
Wetland T	PFO1B	1.11	TSF Haul Road	Fill
Wetland T	PFO1B*	1.13	TSF Haul Road	Fill

Table K2-2 Summary of Direct Wetland Impacts (Continued)

Wetland ID	Cowardin	Acreage	Mine Activity Area	Impact Type
Wetland AAA	PFO1C	0.44	Duckwood TSF	Fill
Wetland AAA	PFO1C	0.96	Duckwood TSF	Fill
Wetland AAA	PFO1C	0.77	Duckwood TSF	Fill
Wetland BBB	PFO1C	1.25	Duckwood TSF	Fill
Wetland DDD	PFO1C	3.41	Duckwood TSF	Fill
Wetland EEE	PFO1C	20.32	Duckwood TSF	Fill
Wetland D	PFO1C	0.51	Pit Related Activities	Fill
Wetland F	PFO1C	0.96	Pit Related Activities	Fill
Wetland F	PFO1C	0.05	Pit Related Activities	Fill
Wetland F	PFO1C	0.60	Pit Related Activities	Fill
Wetland J	PFO1C	0.33	Pit Related Activities	Fill
Wetland J	PFO1C	0.95	Pit Related Activities	Fill
Wetland L	PFO1C	0.31	Pit Related Activities	Fill
Wetland M	PFO1C	0.65	Pit Related Activities	Fill
Wetland N	PFO1C	0.16	Pit Related Activities	Fill
Wetland F	PFO1C	0.03	Johnny's OSA	Fill
Wetland F	PFO1C	0.54	Johnny's OSA	Fill
Wetland F	PFO1C	5.66	Johnny's OSA	Fill
Wetland N	PFO1C	1.27	Johnny's OSA	Fill
Wetland D	PFO1C	0.40	Ramona's OSA	Fill
Wetland E	PFO1C	0.27	Ramona's OSA	Fill
Wetland L	PFO1C	3.27	601 OSA	Fill
Wetland CC	PFO1C	0.51	Champion Pit	Fill
Wetland HH	PFO1C	0.25	Champion Pit	Fill
Wetland CC	PFO1H	0.09	Champion Pit	Fill
Wetland F	PFO1Hh	0.08	Pit Related Activities	Fill
Reach F	POWHh	9.51	Pit Related Activities	Fill
Reach E	POWHh	1.48	Ramona's OSA	Fill
Wetland AAA	PSS1/POWHb	1.91	Duckwood TSF	Fill
Wetland EEE	PSS1C	5.28	Duckwood TSF	Fill
Wetland F	PSS1C	0.36	Pit Related Activities	Fill
Wetland F	PSS1C	1.21	Pit Related Activities	Fill
Wetland J	PSS1C	0.28	Pit Related Activities	Fill

Table K2-2 Summary of Direct Wetland Impacts (Continued)

Wetland ID	Cowardin	Acreage	Mine Activity Area	Impact Type
Wetland BB	PSS1C	0.34	Champion Pit	Fill
Wetland EE	PSS1C	0.12	Champion Pit	Fill
Wetland JJ	PSS1C	0.42	Champion Pit	Fill
Wetland KK	PSS1C	0.17	Champion Pit	Fill
Wetland F	PSS1Hh	0.42	Pit Related Activities	Fill
Total		120.46		

APPENDIX K3

Summary of Indirect Wetland Impacts

List of Tables

Table K3-1 Summary of Indirect Wetland Impacts Inside the Project Boundary

Wetland	Cowardin Habitat Type	Acres	Subwatershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows	Maximum Change in Total Flows	Watershed Alterations		Combined Indirect Impact Factor	Permanent Change in Community Structure and/or Partial Loss of Function
				Feet	1-5 feet	>5 ft	<1 ft by Year 54	CPS vs. SAP	% Change CFS	% Change CFS	Long Term Topographic Change	Habitat Fragmentation		
Wetland RRR	PFO1B	5.84	Buffalo Creek	0.00	0	0	N/A	CPS	-100%	2%	None/Slight	None	No impact	None
Wetland RRR	PFO1B	0.06	Buffalo Creek	0.00	0	0	N/A	CPS	-100%	2%	None/Slight	None	No impact	None
Wetland SSS	PFO1B	0.13	Buffalo Creek	0.22	0	0	N/A	CPS	-1%	2%	None/Slight	None	No impact	None
Wetland RRR	PFO1B*	0.65	Buffalo Creek	0.00	0	0	N/A	CPS	-100%	2%	None/Slight	None	No impact	None
Wetland SS	PSS1C	0.18	Lower Camp Branch Creek	0.05	0	0	N/A	SAP	-9%	9%	None/Slight	None	No impact	None
Wetland SS	PSS1C	0.54	Lower Camp Branch Creek	0.05	0	0	N/A	SAP	-9%	9%	None/Slight	None	No impact	None
Wetland NN	PFO1B	0.08	Unnamed tributary near Camp Branch Creek	0.03	0	0	N/A	SAP	-9%	12%	None/Slight	None	No impact	None
Wetland NN	PFO1H	0.10	Unnamed tributary near Camp Branch Creek	0.08	0	0	N/A	SAP	-30%	12%	None/Slight	None	No impact	None
Wetland VV	PFO1B	0.13	Upper Camp Branch Creek	0.08	0	0	N/A	SAP	-8%	10%	None/Slight	Moderate	Moderate	Moderate
Wetland WW	PFO1B	0.39	Upper Camp Branch Creek	0.12	0	0	N/A	SAP	-10%	10%	None/Slight	Moderate	Moderate	Moderate
Wetland VV	PFO1B*	0.01	Upper Camp Branch Creek	0.06	0	0	N/A	SAP	-8%	10%	None/Slight	Moderate	Moderate	Moderate
Wetland WW	POWH	0.08	Upper Camp Branch Creek	0.13	0	0	N/A	SAP	-14%	10%	None/Slight	Moderate	Moderate	Moderate
Wetland DD	PFO1B	0.04	Unnamed tributary near western side of Champion Pit	0.31	0	0	N/A	SAP	-71%	26%	Major	Moderate	Moderate	Moderate
Wetland AAA	PFO1B	0.42	Upper Camp Branch Creek	0.05	0	0	N/A	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland GGG	PFO1B	0.16	Upper Camp Branch Creek	0.78	0	0	N/A	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland LLL	PFO1B	0.35	Upper Camp Branch Creek	0.52	0	0	N/A	CPS	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland QQQ	PFO1B	1.57	Upper Camp Branch Creek	0.20	0	0	N/A	CPS	-3%	10%	Moderate	Moderate	Moderate	Moderate
Wetland QQQ	PFO1B	4.88	Upper Camp Branch Creek	0.32	0	0	N/A	CPS	-3%	10%	Moderate	Moderate	Moderate	Moderate
Wetland SS	PFO1B	0.13	Upper Camp Branch Creek	0.12	0	0	N/A	SAP	-8%	10%	Major	Moderate	Moderate	Moderate
Wetland SS	PFO1B	4.85	Upper Camp Branch Creek	0.22	0	0	N/A	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland SS	PFO1B	0.13	Upper Camp Branch Creek	0.78	0	0	N/A	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland SS	PFO1B	0.03	Upper Camp Branch Creek	0.78	0	0	N/A	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland YY	PFO1B	0.48	Upper Camp Branch Creek	0.03	0	0	N/A	SAP	-6%	10%	Major	Moderate	Moderate	Moderate
Wetland YY	PFO1B	0.02	Upper Camp Branch Creek	0.33	0	0	N/A	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland YY	PFO1B	0.01	Upper Camp Branch Creek	0.41	0	0	N/A	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland SS	PFO1C	0.01	Upper Camp Branch Creek	0.01	0	0	N/A	SAP	-4%	10%	Major	Moderate	Moderate	Moderate
Wetland SS	PFO1C	0.16	Upper Camp Branch Creek	0.01	0	0	N/A	SAP	-4%	10%	Major	Moderate	Moderate	Moderate
Wetland SS	PSS1/POWHb	4.25	Upper Camp Branch Creek	0.21	0	0	N/A	SAP	-4%	10%	Major	Moderate	Moderate	Moderate
Wetland T	PFO1B	5.20	Upper Haile Gold Mine Creek	0.76	0	0	N/A	CPS	-31%	35%	Major	Major	Major	Major

Wetland	Cowardin Habitat Type	Acres	Subwatershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows	Maximum Change in Total Flows	Watershed Alterations		Combined Indirect Impact Factor	Permanent Change in Community Structure and/or Partial Loss of Function
				Feet	1-5 feet	>5 ft	<1 ft by Year 54	CPS vs. SAP	% Change CFS	% Change CFS	Long Term Topographic Change	Habitat Fragmentation		
Wetland A	PSS1C	0.10	Unnamed tributary near Camp Branch Creek	11.46	18	10	Yes	SAP	N/A	12%	None/Slight	None	Major	Major
Wetland NN	POWHh	0.90	Unnamed tributary near Camp Branch Creek	1.77	8	0	Yes	SAP	-27%	12%	None/Slight	None	Moderate	Moderate
Wetland X	PFO1B	0.53	Unnamed tributary southeast of the Project boundary	51.66	1	52	No	CPS	-100%	36%	None/Slight	None	Major	Major
Wetland F	PFO1B	0.02	Haile Gold Mine Creek within Mining Area	80.16	0	>54	No	SAP	-78%	63%	Major	Major	Major	Major
Wetland F	PFO1B	0.02	Haile Gold Mine Creek within Mining Area	103.81	0	>54	No	SAP	-78%	63%	Major	Major	Major	Major
Wetland F	PFO1B	0.14	Haile Gold Mine Creek within Mining Area	19.97	9	16	Yes	CPS	-100%	63%	Major	Major	Major	Major
Wetland F	PFO1B	0.59	Haile Gold Mine Creek within Mining Area	41.20	4	22	Yes	CPS	-100%	63%	Major	Major	Major	Major
Wetland F	PFO1B	0.04	Lower Haile Gold Mine Creek	62.48	25	29	No	SAP	-78%	42%	Moderate	Moderate	Major	Major
Wetland G	PFO1C	0.43	Lower Haile Gold Mine Creek	80.06	26	28	No	SAP	-100%	42%	Moderate	Moderate	Major	Major
Wetland G	PFO1C	1.48	Lower Haile Gold Mine Creek	80.69	2	52	No	CPS	-100%	42%	Moderate	Moderate	Major	Major
Wetland G	PFO1F	3.08	Lower Haile Gold Mine Creek	61.81	26	27	No	SAP	-100%	42%	Moderate	Moderate	Major	Major
Wetland F	PFO1B	0.16	Lower Haile Gold Mine Creek	7.95	6	17	Yes	SAP	-78%	42%	Moderate	Moderate	Major	Major
Wetland F	PFO1B	0.15	Lower Haile Gold Mine Creek	8.12	12	11	Yes	SAP	-89%	42%	Moderate	Moderate	Major	Major
Wetland F	PFO1B	0.06	Lower Haile Gold Mine Creek	20.05	6	18	Yes	SAP	-100%	42%	Moderate	Moderate	Major	Major
Wetland A	PEM1C	0.38	Unnamed tributary near southern side of Champion Pit	5.37	46	7	No	SAP	-51%	22%	Major	None	Major	Major
Wetland CC	PFO1B	0.46	Unnamed tributary near southern side of Champion Pit	12.75	45	8	No	SAP	-90%	22%	Major	None	Major	Major
Wetland CC	PFO1C	0.00	Unnamed tributary near southern side of Champion Pit	72.38	0	>54	No	SAP	N/A	22%	Major	None	Major	Major
Wetland BB	PSS1C	0.46	Unnamed tributary near southern side of Champion Pit	22.91	31	23	No	SAP	-94%	22%	Major	None	Major	Major
Wetland AA	PFO1B	0.66	Unnamed tributary near southern side of Champion Pit	12.77	12	12	Yes	SAP	-73%	22%	Major	None	Major	Major
Wetland EE	PFO1C	0.09	Unnamed tributary near western side of Champion Pit	36.89	31	23	No	SAP	N/A	26%	Major	None	Major	Major
Wetland HH	PFO1C	0.32	Unnamed tributary near western side of Champion Pit	21.90	33	21	No	SAP	-100%	26%	Major	None	Major	Major

Wetland	Cowardin Habitat Type	Acres	Subwatershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows	Maximum Change in Total Flows	Watershed Alterations		Combined Indirect Impact Factor	Permanent Change in Community Structure and/or Partial Loss of Function
				Feet	1-5 feet	>5 ft	<1 ft by Year 54	CPS vs. SAP	% Change CFS	% Change CFS	Long Term Topographic Change	Habitat Fragmentation		
Wetland EE	PSS1C	0.26	Unnamed tributary near western side of Champion Pit	42.06	26	28	No	SAP	N/A	26%	Major	None	Major	Major
Wetland DD	PFO1B	0.21	Unnamed tributary near western side of Champion Pit	12.04	17	11	Yes	SAP	-76%	26%	Major	None	Major	Major
Wetland HH	PFO1B	0.16	Unnamed tributary near western side of Champion Pit	9.59	20	3	Yes	SAP	-82%	26%	Major	None	Major	Major
Wetland DD	PSS1C	0.44	Unnamed tributary near western side of Champion Pit	5.10	12	1	Yes	SAP	-67%	26%	Major	None	Major	Major
Wetland WW	PFO1B	1.73	Upper Camp Branch Creek	6.11	38	13	No	CPS	-14%	10%	None/Slight	Moderate	Major	Major
Wetland XX	PFO1B	1.51	Upper Camp Branch Creek	10.39	25	26	No	SAP	-19%	10%	None/Slight	Moderate	Major	Major
Wetland XX	PFO1B	4.43	Upper Camp Branch Creek	10.47	25	26	No	CPS	-19%	10%	None/Slight	Moderate	Major	Major
Wetland ZZ	PFO1B	0.58	Upper Camp Branch Creek	5.25	45	6	No	CPS	-5%	10%	Moderate	Moderate	Major	Major
Wetland YY	PFO1C	0.04	Upper Camp Branch Creek	3.72	45	0	Yes	CPS	-5%	10%	Moderate	Moderate	Major	Major
Wetland FFF	PFO1B	0.21	Upper Camp Branch Creek	1.98	21	0	Yes	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland GGG	PFO1B	0.15	Upper Camp Branch Creek	1.12	6	0	Yes	CPS	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland KKK	PFO1B	0.28	Upper Camp Branch Creek	1.27	7	0	Yes	SAP	-5%	10%	Moderate	Moderate	Moderate	Moderate
Wetland LLL	PFO1B	0.25	Upper Camp Branch Creek	1.24	7	0	Yes	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland LLL	PFO1B	0.00	Upper Camp Branch Creek	1.49	14	0	Yes	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland PPP	PFO1B	0.46	Upper Camp Branch Creek	1.80	20	0	Yes	SAP	-3%	10%	Major	Moderate	Moderate	Moderate
Wetland QQQ	PFO1B	1.81	Upper Camp Branch Creek	1.26	7	0	Yes	SAP	-3%	10%	Moderate	Moderate	Moderate	Moderate
Wetland SS	PFO1B	0.19	Upper Camp Branch Creek	1.14	6	0	Yes	SAP	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland SS	PFO1B	0.76	Upper Camp Branch Creek	1.42	13	0	Yes	CPS	-5%	10%	Major	Moderate	Moderate	Moderate
Wetland F	PFO1B	1.19	Upper Haile Gold Mine Creek	62.25	17	36	No	SAP	-63%	35%	Moderate	Major	Major	Major
Wetland O	PFO1B	4.64	Upper Haile Gold Mine Creek	36.73	32	21	No	SAP	-94%	35%	None/Slight	Major	Major	Major
Wetland P	PFO1B	3.67	Upper Haile Gold Mine Creek	21.59	22	30	No	CPS	-100%	35%	None/Slight	Major	Major	Major
Wetland P	PFO1B	10.41	Upper Haile Gold Mine Creek	23.34	1	51	No	CPS	-100%	35%	None/Slight	Major	Major	Major
Wetland Q	PFO1B	9.97	Upper Haile Gold Mine Creek	5.71	45	6	No	CPS	-87%	35%	None/Slight	Major	Major	Major
Wetland T	PFO1B	4.40	Upper Haile Gold Mine Creek	4.61	45	0	No	CPS	-28%	35%	Moderate	Major	Major	Major
Wetland T	PFO1B	0.12	Upper Haile Gold Mine Creek	5.78	38	12	No	CPS	-21%	35%	Moderate	Major	Major	Major
Wetland T	POWHh	0.39	Upper Haile Gold Mine Creek	5.63	43	7	No	CPS	-21%	35%	Moderate	Major	Major	Major
Wetland Q	PFO1B	16.47	Upper Haile Gold Mine Creek	3.11	17	0	Yes	CPS	-85%	35%	None/Slight	Major	Major	Major
Wetland Q	PFO1B	0.90	Upper Haile Gold Mine Creek	11.82	15	11	Yes	CPS	-88%	35%	None/Slight	Major	Major	Major
Wetland R	PFO1B	29.05	Upper Haile Gold Mine Creek	10.27	14	12	Yes	CPS	-51%	35%	Moderate*	Major	Major	Major
Wetland S	PFO1B	16.72	Upper Haile Gold Mine Creek	7.29	22	8	Yes	CPS	-100%	35%	Moderate	Major	Major	Major

Wetland	Cowardin Habitat Type	Acres	Subwatershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows	Maximum Change in Total Flows	Watershed Alterations		Combined Indirect Impact Factor	Permanent Change in Community Structure and/or Partial Loss of Function
				Feet	1-5 feet	>5 ft	<1 ft by Year 54	CPS vs. SAP	% Change CFS	% Change CFS	Long Term Topographic Change	Habitat Fragmentation		
Wetland S	PFO1B	0.08	Upper Haile Gold Mine Creek	9.25	7	5	Yes	SAP	-47%	35%	Moderate	Major	Major	Major
Wetland U	PFO1B	30.61	Upper Haile Gold Mine Creek	1.22	12	0	Yes	CPS	-13%	35%	None/Slight	Major	Major	Major
Wetland Q	PFO1B*	2.93	Upper Haile Gold Mine Creek	2.00	21	0	Yes	CPS	-66%	35%	None/Slight	Major	Major	Major
													Total Moderate	**23.11 acres**
													Total Major	**155.31 acres**
													Total Moderate and Major	**178.43 acres**

Table K3-2 Summary of Indirect Wetland Impacts Outside the Project Boundary

Cowardin	Acres	Watershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows (Subwatershed)	Maximum Change in Total Flows (Subwatershed)	Watershed Alterations		Combined Indirect Impact Factor	Permanent Impacts from Prolonged Hydrological Alterations
			Feet	1-5 feet	> 5 feet	<1 ft by Year 54	CPS or SAP	% Change CFS	% Change CFS	Long term Topographic Change	Habitat Fragmentation		Community Structure
PFO1A	1.07	Headwaters Little Lynches River	1.16	2	0	Yes	SAP	No data	No data	None/Slight	None	Low	None
PFO1A	0.67	Headwaters Little Lynches River	1.19	2	0	Yes	SAP	No data	No data	None/Slight	None	Low	None
PFO1A	20.23	Headwaters Little Lynches River	1.30	3	0	Yes	SAP	No data	No data	None/Slight	None	Low	None
PFO1A	0.73	Headwaters Little Lynches River	1.38	3	0	Yes	SAP	No data	No data	None/Slight	None	Low	None
PFO1A	0.94	Headwaters Little Lynches River	1.43	3	0	Yes	SAP	No data	No data	None/Slight	None	Low	None
PFO1A	13.60	Headwaters Little Lynches River	1.70	3	0	Yes	SAP	No data	No data	None/Slight	None	Low	None
PFO1A	0.27	Headwaters Little Lynches River	0.03	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	0.26	Headwaters Little Lynches River	0.05	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	0.02	Headwaters Little Lynches River	0.05	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	2.70	Headwaters Little Lynches River	0.06	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	6.79	Headwaters Little Lynches River	0.48	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	1.98	Headwaters Little Lynches River	0.62	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	25.11	Headwaters Little Lynches River	0.71	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	1.15	Headwaters Little Lynches River	1.73	3	0	Yes	SAP	No data	No data	None/Slight	None	Low	None
PSS3B	0.88	Headwaters Little Lynches River	0.05	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PSS3B	0.01	Headwaters Little Lynches River	0.05	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PSS3B	9.68	Headwaters Little Lynches River	0.93	0	0	N/A	SAP	No data	No data	None/Slight	None	No impact	None
PFO1A	3.18	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	1.12	1	0	Yes	CPS	7%	4%	None/Slight	None	Low	None
PFO1A	1.48	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	1.19	2	0	Yes	SAP	7%	4%	None/Slight	None	Low	None
PFO1A	0.48	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	1.48	3	0	Yes	SAP	7%	4%	None/Slight	None	Low	None
PFO1A	0.00	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	0.02	0	0	N/A	SAP	7%	4%	None/Slight	None	No impact	None
PFO1A	0.13	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	0.02	0	0	N/A	SAP	7%	4%	None/Slight	None	No impact	None
PFO1A	0.05	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	0.02	0	0	N/A	SAP	7%	4%	None/Slight	None	No impact	None
PFO1A	0.03	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	0.02	0	0	N/A	SAP	7%	4%	None/Slight	None	No impact	None
POWHh	1.00	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	1.05	1	0	Yes	SAP	7%	4%	None/Slight	None	Low	None

Cowardin	Acres	Watershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows (Subwatershed)	Maximum Change in Total Flows (Subwatershed)	Watershed Alterations		Combined Indirect Impact Factor	Permanent Impacts from Prolonged Hydrological Alterations
			Feet	1-5 feet	> 5 feet	<1 ft by Year 54	CPS or SAP	% Change CFS	% Change CFS	Long term Topographic Change	Habitat Fragmentation		Community Structure
POWKx	3.32	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	1.52	2	0	Yes	SAP	7%	4%	None/Slight	None	Low	None
PEM1F	0.22	Lower Camp Branch Creek	0.03	0	0	N/A	SAP	8%	9%	None/Slight	None	No impact	None
PFO1A	0.02	Lower Camp Branch Creek	0.03	0	0	N/A	SAP	8%	9%	None/Slight	None	No impact	None
PFO1A	1.01	Lower Camp Branch Creek	0.10	0	0	N/A	SAP	8%	9%	None/Slight	None	No impact	None
PFO1/4B	0.01	Unnamed tributary near Camp Branch Creek	0.03	0	0	N/A	SAP	20%	12%	None/Slight	None	No impact	None
PFO1/4B	0.00	Unnamed tributary near Camp Branch Creek	0.09	0	0	N/A	SAP	20%	12%	None/Slight	None	No impact	None
PFO1/SS3B	0.02	Unnamed tributary near Camp Branch Creek	0.01	0	0	N/A	SAP	20%	12%	None/Slight	None	No impact	None
PFO1B	0.01	Upper Little Lynches River	0.84	0	0	N/A	CPS	No data	No data	None/Slight	None	No impact	None
PFO1A	0.11	Upper Camp Branch Creek	0.11	0	0	N/A	SAP	7%	10%	None/Slight	Moderate	Moderate	None
PFO1B	0.88	Buffalo Creek	5.89	40	11	No	CPS	2%	2%	None/Slight	None	Major	Major
PFO1A	0.20	Headwaters Little Lynches River	1.13	6	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	0.12	Headwaters Little Lynches River	1.14	6	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	0.75	Headwaters Little Lynches River	1.17	6	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1/4B	4.90	Buffalo Creek	1.65	15	0	Yes	CPS	2%	2%	None/Slight	None	Moderate	Moderate
PFO1A	7.75	Buffalo Creek	2.23	22	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
PFO1A	14.30	Buffalo Creek	2.88	28	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
PFO1A	3.08	Buffalo Creek	1.48	14	0	Yes	CPS	2%	2%	None/Slight	None	Moderate	Moderate
PFO1B	2.32	Buffalo Creek	2.67	23	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
PFO1B	12.89	Buffalo Creek	2.70	29	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
PFO1B	41.08	Buffalo Creek	3.83	35	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
PFO1B	16.11	Buffalo Creek	3.87	40	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
PFO1B	14.20	Buffalo Creek	3.93	30	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
PFO1B	3.97	Buffalo Creek	1.54	14	0	Yes	CPS	2%	2%	None/Slight	None	Moderate	Moderate
PFO1B	9.12	Buffalo Creek	1.75	15	0	Yes	CPS	2%	2%	None/Slight	None	Moderate	Moderate
PFO1B	3.79	Buffalo Creek	1.87	20	0	Yes	SAP	2%	2%	None/Slight	None	Moderate	Moderate
PFO1B	4.94	Buffalo Creek	1.93	16	0	Yes	CPS	2%	2%	None/Slight	None	Moderate	Moderate
POWHh	1.08	Buffalo Creek	6.42	38	13	No	CPS	2%	2%	None/Slight	None	Major	Major
POWHh	0.37	Buffalo Creek	2.19	21	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
POWHh	1.47	Buffalo Creek	2.59	22	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
POWHh	0.61	Buffalo Creek	2.71	28	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major
POWHh	1.00	Buffalo Creek	1.69	15	0	Yes	CPS	2%	2%	None/Slight	None	Moderate	Moderate
PSS1Fh	0.40	Buffalo Creek	2.08	21	0	Yes	CPS	2%	2%	None/Slight	None	Major	Major

Cowardin	Acres	Watershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows (Subwatershed)	Maximum Change in Total Flows (Subwatershed)	Watershed Alterations		Combined Indirect Impact Factor	Permanent Impacts from Prolonged Hydrological Alterations
			Feet	1-5 feet	> 5 feet	<1 ft by Year 54	CPS or SAP	% Change CFS	% Change CFS	Long term Topographic Change	Habitat Fragmentation		Community Structure
PFO1B	2.22	Buffalo Creek-Lynches River	1.25	10	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	0.01	Headwaters Little Lynches River	2.06	11	0	Yes	SAP	No data	No data	None/Slight	None	Major	Major
PFO1A	2.34	Headwaters Little Lynches River	1.24	11	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	1.31	Headwaters Little Lynches River	1.36	17	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	4.47	Headwaters Little Lynches River	1.38	13	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	9.37	Headwaters Little Lynches River	1.46	13	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	30.43	Headwaters Little Lynches River	1.46	13	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	4.50	Headwaters Little Lynches River	1.47	13	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	0.56	Headwaters Little Lynches River	1.50	13	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	28.83	Headwaters Little Lynches River	1.67	8	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	1.33	Headwaters Little Lynches River	1.72	19	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
PFO1A	2.80	Headwaters Little Lynches River	1.75	14	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
POWHh	1.62	Headwaters Little Lynches River	2.02	11	0	Yes	SAP	No data	No data	None/Slight	None	Major	Major
POWHh	0.31	Headwaters Little Lynches River	2.64	20	0	Yes	SAP	No data	No data	None/Slight	None	Major	Major
POWHh	0.60	Headwaters Little Lynches River	1.39	13	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
POWHh	0.26	Headwaters Little Lynches River	1.84	20	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
POWHh	0.66	Headwaters Little Lynches River	1.90	9	0	Yes	SAP	No data	No data	None/Slight	None	Moderate	Moderate
POWHh	0.78	Headwaters Little Lynches River	1.92	20	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1/4B	13.84	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	4.08	22	0	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/4B	1.03	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	6.21	20	2	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	6.85	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	4.01	17	0	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	6.02	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	4.20	18	0	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	0.44	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	5.84	21	2	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	3.23	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	6.05	20	3	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	5.46	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	8.28	20	3	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	4.89	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	9.09	20	3	Yes	SAP	7%	4%	None/Slight	None	Major	Major

Cowardin	Acres	Watershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows (Subwatershed)	Maximum Change in Total Flows (Subwatershed)	Watershed Alterations		Combined Indirect Impact Factor	Permanent Impacts from Prolonged Hydrological Alterations
			Feet	1-5 feet	> 5 feet	<1 ft by Year 54	CPS or SAP	% Change CFS	% Change CFS	Long term Topographic Change	Habitat Fragmentation		Community Structure
PFO1/SS3B	1.25	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	11.06	10	13	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	0.01	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	11.51	7	16	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1/SS3B	0.08	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	12.14	7	16	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1A	0.29	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	1.79	12	0	Yes	SAP	7%	4%	None/Slight	None	Moderate	Moderate
PFO1A	10.60	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	1.87	12	0	Yes	SAP	7%	4%	None/Slight	None	Moderate	Moderate
PFO1C	14.08	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	2.26	12	0	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1C	15.92	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	2.74	12	0	Yes	SAP	7%	4%	None/Slight	None	Major	Major
POWHh	0.26	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	2.81	11	0	Yes	SAP	7%	4%	None/Slight	None	Major	Major
POWHh	0.16	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	3.79	13	0	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PSS1A	9.24	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	6.64	20	3	Yes	SAP	7%	4%	None/Slight	None	Major	Major
PFO1A	8.60	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	3.99	31	0	Yes	SAP	64%	3%	None/Slight	None	Major	Major
PFO1A	13.16	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	1.20	10	0	Yes	SAP	64%	3%	None/Slight	None	Moderate	Moderate
PFO1A	13.16	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	1.95	16	0	Yes	SAP	64%	3%	None/Slight	None	Moderate	Moderate
POWHx	0.33	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	2.08	16	0	Yes	SAP	64%	3%	None/Slight	None	Major	Major
PFO1A	16.75	Lower Camp Branch Creek	10.20	35	18	No	SAP	8%	9%	None/Slight	None	Major	Major
PFO1A	0.03	Lower Camp Branch Creek	13.46	33	20	No	SAP	8%	9%	None/Slight	None	Major	Major
PFO1A	10.23	Lower Camp Branch Creek	14.61	27	26	No	SAP	8%	9%	None/Slight	None	Major	Major
PFO1A	0.88	Lower Camp Branch Creek	18.50	22	31	No	SAP	8%	9%	None/Slight	None	Major	Major

Cowardin	Acres	Watershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows (Subwatershed)	Maximum Change in Total Flows (Subwatershed)	Watershed Alterations		Combined Indirect Impact Factor	Permanent Impacts from Prolonged Hydrological Alterations
			Feet	1-5 feet	> 5 feet	<1 ft by Year 54	CPS or SAP	% Change CFS	% Change CFS	Long term Topographic Change	Habitat Fragmentation		Community Structure
PFO1A	9.45	Lower Camp Branch Creek	3.07	21	0	Yes	SAP	8%	9%	None/Slight	None	Major	Major
PFO1A	22.02	Lower Camp Branch Creek	3.16	25	0	Yes	SAP	8%	9%	None/Slight	None	Major	Major
PFO1A	30.48	Lower Camp Branch Creek	3.55	21	0	Yes	SAP	8%	9%	None/Slight	None	Major	Major
PFO1A	0.06	Lower Camp Branch Creek	6.34	39	8	Yes	SAP	8%	9%	None/Slight	None	Major	Major
PFO1A	2.57	Unnamed tributary southeast of the Project boundary	16.99	21	31	No	CPS	64%	36%	None/Slight	None	Major	Major
PFO1A	31.00	Unnamed tributary southeast of the Project boundary	2.76	16	0	Yes	SAP	64%	36%	None/Slight	None	Major	Major
PFO1A	8.67	Unnamed tributary southeast of the Project boundary	3.23	30	0	Yes	SAP	64%	36%	None/Slight	None	Major	Major
PFO1A	8.71	Unnamed tributary southeast of the Project boundary	5.25	36	5	Yes	SAP	64%	36%	None/Slight	None	Major	Major
PFO1B	56.52	Unnamed tributary southeast of the Project boundary	7.98	40	11	No	CPS	64%	36%	None/Slight	None	Major	Major
PFO1C	33.17	Unnamed tributary southeast of the Project boundary	3.90	26	0	Yes	SAP	64%	36%	None/Slight	None	Major	Major
PFO1F	0.44	Unnamed tributary southeast of the Project boundary	12.32	27	25	No	CPS	64%	36%	None/Slight	None	Major	Major
POWHh	0.15	Unnamed tributary southeast of the Project boundary	5.30	42	5	No	SAP	64%	36%	None/Slight	None	Major	Major
POWHh	0.23	Unnamed tributary southeast of the Project boundary	5.54	0	40	No	SAP	64%	36%	None/Slight	None	Major	Major
POWHh	0.15	Unnamed tributary southeast of the Project boundary	5.47	21	5	Yes	CPS	64%	36%	None/Slight	None	Major	Major
PFO1A	20.96	Upper Little Lynches River	2.78	30	0	Yes	CPS	No data	No data	None/Slight	None	Major	Major
PFO1A	2.32	Upper Little Lynches River	3.26	35	0	Yes	CPS	No data	No data	None/Slight	None	Major	Major
PFO1B	6.20	Upper Little Lynches River	2.39	25	0	Yes	CPS	No data	No data	None/Slight	None	Major	Major
PFO1B	15.27	Upper Little Lynches River	2.46	30	0	Yes	CPS	No data	No data	None/Slight	None	Major	Major
PFO1B	0.05	Upper Little Lynches River	1.24	14	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1B	7.01	Upper Little Lynches River	1.83	19	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1B	3.70	Upper Little Lynches River	1.98	24	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1C	0.17	Upper Little Lynches River	1.18	12	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
PFO1C	6.14	Upper Little Lynches River	1.72	17	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate
POWHh	4.51	Upper Little Lynches River	2.86	34	0	Yes	CPS	No data	No data	None/Slight	None	Major	Major
POWHh	1.81	Upper Little Lynches River	1.56	20	0	Yes	CPS	No data	No data	None/Slight	None	Moderate	Moderate

Cowardin	Acres	Watershed	Max Drawdown Year 14	Total Duration of GW Drawdown	Total Duration of GW Drawdown	Does GW Table Recover?	Geology	Maximum Change in Baseflows (Subwatershed)	Maximum Change in Total Flows (Subwatershed)	Watershed Alterations		Combined Indirect Impact Factor	Permanent Impacts from Prolonged Hydrological Alterations
			Feet	1-5 feet	> 5 feet	<1 ft by Year 54	CPS or SAP	% Change CFS	% Change CFS	Long term Topographic Change	Habitat Fragmentation		Community Structure
PFO1B	0.04	Haile Gold Mine Creek within Mining Area	60.18	16	38	No	SAP	45%	63%	None/Slight	Major	Major	Major
PFO1B	0.20	Haile Gold Mine Creek within Mining Area	80.89	1	53	No	CPS	45%	63%	None/Slight	Major	Major	Major
PFO1B	2.73	Haile Gold Mine Creek within Mining Area	29.71	4	22	Yes	CPS	45%	63%	None/Slight	Major	Major	Major
POWHh	1.64	Haile Gold Mine Creek within Mining Area	57.37	1	53	No	CPS	45%	63%	None/Slight	Major	Major	Major
POWHh	0.53	Haile Gold Mine Creek within Mining Area	69.44	1	53	No	CPS	45%	63%	None/Slight	Major	Major	Major
POWHh	3.59	Haile Gold Mine Creek within Mining Area	70.89	1	53	No	SAP	45%	63%	None/Slight	Major	Major	Major
PFO1A	1.13	Lower Haile Gold Mine Creek	20.69	36	17	No	SAP	48%	42%	Moderate	Moderate	Major	Major
PFO1A	13.90	Lower Haile Gold Mine Creek	3.12	18	0	Yes	SAP	48%	42%	Moderate	Moderate	Major	Major
PFO1/SS3B	11.55	Unnamed tributary near southern side of Champion Pit	5.83	16	2	Yes	SAP	49%	22%	Major	None	Major	Major
PFO1/SS3B	18.46	Unnamed tributary near southern side of Champion Pit	8.80	20	3	Yes	SAP	49%	22%	Major	None	Major	Major
PFO1/SS3B	6.77	Unnamed tributary near western side of Champion Pit	4.43	17	0	Yes	SAP	54%	26%	Moderate	None	Major	Major
PFO1A	20.81	Unnamed tributary near western side of Champion Pit	24.37	27	27	No	SAP	54%	26%	Moderate	None	Major	Major
POWHh	0.12	Unnamed tributary near western side of Champion Pit	16.76	27	26	No	SAP	54%	26%	Moderate	None	Major	Major
POWHh	1.49	Unnamed tributary near western side of Champion Pit	32.83	1	53	No	SAP	54%	26%	Moderate	None	Major	Major
PFO1A	2.26	Upper Camp Branch Creek	4.23	36	0	Yes	SAP	7%	10%	None/Slight	Moderate	Major	Moderate
PFO1A	6.59	Upper Camp Branch Creek	1.22	11	0	Yes	CPS	7%	10%	None/Slight	Moderate	Moderate	Moderate
PFO1A	3.52	Upper Camp Branch Creek	1.43	15	0	Yes	SAP	7%	10%	None/Slight	Moderate	Moderate	Moderate
PFO1B	14.64	Upper Camp Branch Creek	1.21	11	0	Yes	CPS	7%	10%	None/Slight	Moderate	Moderate	Moderate
POWHh	3.65	Upper Camp Branch Creek	1.17	6	0	Yes	CPS	7%	10%	None/Slight	Moderate	Moderate	Moderate
POWHh	0.51	Upper Camp Branch Creek	1.75	24	0	Yes	CPS	7%	10%	None/Slight	Moderate	Moderate	Moderate
PSS1A	4.57	Upper Haile Gold Mine Creek	4.22	40	0	Yes	CPS	61%	35%	None/Slight	Major	Major	Major
												Total Major	**577.67 acres**
												Total Moderate	**207.44 acres**
												Total Moderate and Major	**785.11 acres**

Table K3-3 Indirect Impact Matrix Criteria for Wetlands

Groundwater Depressurization				
Max change in annual average GW Drawdown	No impact: <1 foot	low impact: 1-2 feet	moderate impact: 2-5 feet	major impact: >5 feet
Total Duration of GW Drawdown (1-5 foot)	0 years of drawdown in 1-5 foot zone = no impact (unless drawdown occurs rapidly and exceeds 5 feet, see below)	if max drawdown is 1-2 feet, short term temporal loss = 1-3 years	If max drawdown is 1-2 feet, 4-10 years will result in moderate temporal loss; if drawdown is 2-5 feet max, moderate temporal loss or greater (1-2 feet); 1-5 years (2-5 feet)	> 10 years (1-2 foot); > 5 years (2-5 feet) = long term temporal loss
Total Duration of GW Drawdown (> 5 foot)	0 years= no impact unless drawdown occurs in 1-5 foot zone (see above)	1 year = short term temporal loss (unless drawdown occurs in 1-5 foot zone for more than 10 years, in which case it will have long-term temporal loss)	2-3 years moderate temporal loss (unless drawdown occurs in 1-5 foot zone for more than 10 years, in which case it will have long-term temporal loss)	>3 years long term temporal loss
Does GW table recover (<1 foot) by Year 54)?	N/A	YES	NO	
Geology (CPS vs. Sap)	None= any areas with less than 1 foot of GW drawdown	Moderate-Lower lying saprolite areas where it sits closer to the surface with minimal or no CPS layer will have moderate potential for drawdown; AND saprolite areas with thick top layer of CPS (but saprolite occurs at the surface of the bottom of the wetland).	Major-CPS areas (where CPS is thick and extends below the bottom of the wetland) are going to have high susceptibility to drawdown at the surface.	

Flows				
Maximum change in annual average baseflows (low flow conditions <0.25 cfs)	<20% Negligible	20-50% Moderate change	>50% Major change	
Maximum change in annual average baseflows and total flows (normal flow conditions >0.25 cfs)	<10% Negligible	10-20% Moderate change	>20% Major change	
Watershed Alterations				
Long Term Topographic Change	No change/Low=slight loss of surface runoff/seepage from topographic changes in contributing watershed	Moderate change=some loss of surface runoff/seepage from topographic changes in contributing watershed	Major change=> source of contributing watershed for surface runoff and seepage is completely removed	
Habitat Fragmentation	None	Moderate- some level of fragmentation in Upper Camp Branch and Lower Haile Gold Mine Creek	Major-Upper Haile Gold Mine Creek completed severed from downstream portion of HGM Creek except for hydrologic connection from stream diversion pipe	

Permanent Changes from Prolonged Periods of Dewatering				
Community Structure and Partial Loss of Wetland Function	No change- less than 1 foot of drawdown; no habitat fragmentation; OR 1-2 feet of drawdown for short duration (1-3 years)	Moderate change= any areas between 1-2 feet of drawdown for prolonged periods of time (3-10+ years) OR > 5 feet for 2-3 years	Major change= any areas subjected to habitat fragmentation; any areas where GW table does not recover by Year 54; any areas that are exposed to 2-5 feet of drawdown for prolonged periods of time (>10 years) OR > 5 feet for > 3 years	
Combined Indirect Impact Factor	No impact=green for all variables	Low=Water table recovers, No habitat fragmentation; GW drawdown in 1-2 foot zone only; short term temporal loss; also considers baseflows	Moderate=Moderate habitat fragmentation; groundwater drawdown between 1-2 feet for > 4 years (moderate -long term temporal loss); also considers topographic change, baseflows and geology.	Major=Major habitat fragmentation; water table does not recover; groundwater drawdown > 5 feet for prolonged periods of time; total duration = > 10 years; also considers topographic change, baseflows and geology.

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APPENDIX K4

Summary of Indirect Stream Impacts

List of Tables

Table K4-1 Summary of Indirect Stream Impacts inside the Project Boundary

Stream ID	Cowardin	Impact (linear feet)	Subwatershed	Watershed Alterations		Change in Groundwater Baseflows						Change in Total Flows						Combined Indirect Impact Factor
						Active Mining Phase (Year 0-14)				Post Mining (After Year 14)						Post Mining (After Year 14)		
				Long Term Topographic Change	Habitat Fragment-ation	Years of 10-20% Change in Baseflows	Years of >20% Change in Baseflows	Maximum Change in Baseflows	Year of Max Baseflow Reduction	Post Mining Duration of Impact Until Recovery	Total Duration of Baseflow Impact	Years of 10-20% Change in Total Flow	Years of >20% Change in Total Flows	Maximum Change in Total flows	Year of Max Change in Total Flows	Post Mining Duration of Impact Until Recovery	Total Duration of Total Flow Impact	
Reach A	R2UB2H	1,215.94	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	None/slight	None	4	0	10%	14	5-10	9-14	0	0	4%	12	No data	No data	Low
Reach A	R2UB2H	2,633.17	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	None/slight	None	0	0	1%	14	0	0	0	0	4%	12	No data	No data	Low
Reach SS	R2UB2H	2,633.17	Lower Camp Branch Creek	None/slight	None	0	0	8%	14	0	0	0	0	9%	12	No data	No data	Low
Reach F	R2UB2H	1,891.15	Lower Haile Gold Mine Creek	Major	Moderate	0	14	75%	14	NA	>54	0	12	42%	8	No data	No data	Major
Reach G	R2UB2H	1,891.15	Lower Haile Gold Mine Creek	Moderate	Moderate	0	14	100%	8	NA	>54	0	12	42%	8	No data	No data	Major
Reach H	R2UB2H	1,601.01	Lower Haile Gold Mine Creek	Major	Moderate	0	14	100%	5	NA	>54	0	12	42%	8	No data	No data	Major
Reach I	R4SB4C	666.76	Lower Haile Gold Mine Creek	Major	Moderate	0	14	100%	14	NA	>54	0	12	42%	8	No data	No data	Major
Reach NN	R2UB2H	1,253.74	Unnamed tributary near Camp Branch Creek	None/slight	None	8	3	28%	14	10-15	21-26	2	0	12%	12	No data	No data	Major
Reach NN	R2UB2H	951.76	Unnamed tributary near Camp Branch Creek	None/slight	None	4	2	21%	14	5-10	11-16	2	0	12%	12	No data	No data	Major
Reach D	R4SB4C	715.05	Unnamed tributary near middle of Ramona OSA	Moderate	None	1	13	62%	5	NA	>54	0	12	45%	12	No data	No data	Major

Stream ID	Cowardin	Impact (linear feet)	Subwatershed	Watershed Alterations		Change in Groundwater Baseflows						Change in Total Flows						Combined Indirect Impact Factor
						Active Mining Phase (Year 0-14)				Post Mining (After Year 14)						Post Mining (After Year 14)		
				Long Term Topographic Change	Habitat Fragment-ation	Years of 10-20% Change in Baseflows	Years of >20% Change in Baseflows	Maximum Change in Baseflows	Year of Max Baseflow Reduction	Post Mining Duration of Impact Until Recovery	Total Duration of Baseflow Impact	Years of 10-20% Change in Total Flow	Years of >20% Change in Total Flows	Maximum Change in Total flows	Year of Max Change in Total Flows	Post Mining Duration of Impact Until Recovery	Total Duration of Total Flow Impact	
Reach C	R4SB4C	1,215.94	Unnamed tributary near south eastern side of Ramona OSA	Moderate	None	0	13	44%	5	NA	>54	0	12	26%	5	No data	No data	Major
Reach E	R4SB4C	571.57	Unnamed tributary near south western side of Ramona OSA	Moderate	None	1	12	33%	5	10-15	23-28	0	12	27%	12	No data	No data	Major
Reach AA	R2UB2H	1,063.79	Unnamed tributary near southern side of Champion Pit	Major	None	0	13	71%	14	20-25	33-38	10	2	22%	12	No data	No data	Major
Reach BB	R2UB2H	411.99	Unnamed tributary near southern side of Champion Pit	Major	None	1	11	85%	14	NA	>54	10	2	22%	12	No data	No data	Major
Reach CC	R2UB2H	1,063.79	Unnamed tributary near southern side of Champion Pit	Major	None	1	13	88%	14	NA	>54	10	2	22%	12	No data	No data	Major
Reach DD	R2UB2H	667.83	Unnamed tributary near western side of Champion Pit	Major	None	1	12	61%	14	25-30	38-43	12	2	26%	12	No data	No data	Major
Reach EE	R4SB4C	667.83	Unnamed tributary near western side of Champion Pit	Major	None	No data	No data	No data	No data	No data	No data	No data	No data	26%	12	No data	No data	Major
Reach HH	R4SB4C	807.31	Unnamed tributary near western side of Champion Pit	Major	None	0	13	79%	14	NA	>54	12	2	26%	12	No data	No data	Major

Stream ID	Cowardin	Impact (linear feet)	Subwatershed	Watershed Alterations		Change in Groundwater Baseflows						Change in Total Flows						Combined Indirect Impact Factor
						Active Mining Phase (Year 0-14)				Post Mining (After Year 14)	Total Duration of Baseflow Impact	Years of 10-20% Change in Total Flow	Years of >20% Change in Total Flows	Maximum Change in Total flows	Year of Max Change in Total Flows	Post Mining (After Year 14)	Total Duration of Total Flow Impact	
				Long Term Topographic Change	Habitat Fragment-ation	Years of 10-20% Change in Baseflows	Years of >20% Change in Baseflows	Maximum Change in Baseflows	Year of Max Baseflow Reduction	Post Mining Duration of Impact Until Recovery						Post Mining Duration of Impact Until Recovery		
Reach II	R4SB4C	440.09	Unnamed tributary near western side of Champion Pit	Major	None	1	12	74%	14	NA	>54	12	2	26%	12	No data	No data	Major
Reach JJ	R4SB4C	25.92	Unnamed tributary near western side of Champion Pit	Major	None	1	13	86%	14	NA	>54	12	2	26%	12	No data	No data	Major
Reach KK	R4SB4C	29.44	Unnamed tributary near western side of Champion Pit	Major	None	1	13	86%	14	NA	>54	12	2	26%	12	No data	No data	Major
Reach AAA	R2UB2H	1,122.17	Upper Camp Branch Creek	Major	Moderate	0	0	4%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach FFF	R2UB2H	265.19	Upper Camp Branch Creek	Major	Moderate	0	0	4%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach GGG	R4SB4C	696.12	Upper Camp Branch Creek	Major	Moderate	0	0	4%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach KKK	R4SB4C	1,211.27	Upper Camp Branch Creek	Moderate	Moderate	0	0	5%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach LLL	R4SB4C	1,201.83	Upper Camp Branch Creek	Major	Moderate	0	0	5%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach OOO	R2UB2H	3,106.64	Upper Camp Branch Creek	Moderate	Moderate	0	0	2%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach OOO	R2UB2H	1,030.05	Upper Camp Branch Creek	Moderate	Moderate	0	0	2%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach OOO	R2UB2H	6.66	Upper Camp Branch Creek	Moderate	Moderate	0	0	2%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach PPP	R4SB4C	892.20	Upper Camp Branch Creek	Major	Moderate	0	0	2%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach QQQ	R2UB2H	3,106.64	Upper Camp Branch Creek	Moderate	Moderate	0	0	2%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach SS	R2UB2H	1,876.52	Upper Camp Branch Creek	Moderate	Moderate	0	0	7%	14	0	0	2	0	10%	12	No data	No data	Moderate

Stream ID	Cowardin	Impact (linear feet)	Subwatershed	Watershed Alterations		Change in Groundwater Baseflows						Change in Total Flows						Combined Indirect Impact Factor
						Active Mining Phase (Year 0-14)				Post Mining (After Year 14)						Post Mining (After Year 14)		
				Long Term Topographic Change	Habitat Fragment-ation	Years of 10-20% Change in Baseflows	Years of >20% Change in Baseflows	Maximum Change in Baseflows	Year of Max Baseflow Reduction	Post Mining Duration of Impact Until Recovery	Total Duration of Baseflow Impact	Years of 10-20% Change in Total Flow	Years of >20% Change in Total Flows	Maximum Change in Total flows	Year of Max Change in Total Flows	Post Mining Duration of Impact Until Recovery	Total Duration of Total Flow Impact	
Reach SS	R2UB2H	265.19	Upper Camp Branch Creek	Major	Moderate	0	0	4%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach SS	R2UB2H	414.91	Upper Camp Branch Creek	Major	Moderate	0	0	3%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach SS	R2UB2H	1,122.17	Upper Camp Branch Creek	Major	Moderate	0	0	4%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach VV	R2UB2H	564.58	Upper Camp Branch Creek	None/slight	Moderate	0	0	7%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach WW	R2UB2H	1,448.31	Upper Camp Branch Creek	None/slight	Moderate	5	0	13%	14	5-10	10-15	2	0	10%	12	No data	No data	Moderate
Reach XX	R2UB2H	1,565.50	Upper Camp Branch Creek	None/slight	Moderate	0	11	61%	14	NA	>54	2	0	10%	12	No data	No data	Moderate
Reach YY	R4SB4C	3,953.53	Upper Camp Branch Creek	Moderate	Moderate	0	0	5%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach ZZ	R2UB2H	1,423.84	Upper Camp Branch Creek	Moderate	Moderate	0	0	4%	14	0	0	2	0	10%	12	No data	No data	Moderate
Reach F	R2UB2H	4,736.31	Upper Haile Gold Mine Creek	Moderate	Major	1	11	61%	14	NA	>54	2	10	35%	12	No data	No data	Major
Reach O	R2UB2H	4,736.31	Upper Haile Gold Mine Creek	None/slight	Major	1	12	93%	14	NA	>54	2	10	35%	12	No data	No data	Major
Reach P	R2UB2H	914.66	Upper Haile Gold Mine Creek	None/slight	Major	0	13	100%	14	NA	>54	2	10	35%	12	No data	No data	Major
Reach P	R2UB2H	1,421.46	Upper Haile Gold Mine Creek	None/slight	Major	0	13	100%	14	NA	>54	2	10	35%	12	No data	No data	Major
Reach Q	R2UB2H	246.16	Upper Haile Gold Mine Creek	None/slight	Major	1	11	84%	14	NA	>54	2	10	35%	12	No data	No data	Major
Reach R	R2UB2H	4,736.31	Upper Haile Gold Mine Creek	Moderate	Major	1	10	49%	14	35-40	46-51	2	10	35%	12	No data	No data	Major
Reach S	R2UB2H	4,736.31	Upper Haile Gold Mine Creek	Moderate	Major	1	11	100%	14	NA	>54	2	10	35%	12	No data	No data	Major
Reach T	R2UB2H	1,125.96	Upper Haile Gold Mine Creek	Moderate	Major	3	5	25%	14	20-25	28-33	2	10	35%	12	No data	No data	Major
Reach T	R2UB2H	1,400.88	Upper Haile Gold Mine Creek	Moderate	Major	3	6	28%	14	20-25	29-34	2	10	35%	12	No data	No data	Major

Stream ID	Cowardin	Impact (linear feet)	Subwatershed	Watershed Alterations		Change in Groundwater Baseflows						Change in Total Flows						Combined Indirect Impact Factor
						Active Mining Phase (Year 0-14)				Post Mining (After Year 14)	Total Duration of Baseflow Impact	Years of 10-20% Change in Total Flow	Years of >20% Change in Total Flows	Maximum Change in Total flows	Year of Max Change in Total Flows	Post Mining (After Year 14)	Total Duration of Total Flow Impact	
				Long Term Topographic Change	Habitat Fragment-ation	Years of 10-20% Change in Baseflows	Years of >20% Change in Baseflows	Maximum Change in Baseflows	Year of Max Baseflow Reduction	Post Mining Duration of Impact Until Recovery						Post Mining Duration of Impact Until Recovery		
Reach U	R2UB2H	927.25	Upper Haile Gold Mine Creek	None/slight	Major	4	0	12%	14	5-10	9-14	2	10	35%	12	No data	No data	Major
Total Major																		40,917.73 LF
Total Moderate																		25,273.31 LF
Total Moderate and Major =>																		66,191.04 LF

Notes:

LF: Linear Feet

Table K4-2 Summary of Indirect Stream Impacts Outside the Project Boundary

Cowardin	Impact (Linear Feet)	Subwatershed	Watershed Alteration		Change in Flows (by Subwatershed)							Combined Indirect Impact Factor
					Active Mining (Year 0-14)					Post Mining (After Year 14)	Duration of Impact	
			Long Term Topographic Change	Habitat Fragmentation	Maximum Change in Baseflows	Years of 10-20% Change in Total Flows	Years of >20% Change in Total Flows	Maximum Change in Total flows	Year of Maximum Change in Total Flows	Post Mining Duration of Impact Until Recovery		
R2UB2H	847.67	Haile Gold Mine Creek within Mining Area	None/Slight	Major	45%	2	12	63%	8	No data	No data	Major
R2UB2H	960.59	Lower Haile Gold Mine Creek	Moderate	Moderate	48%	0	12	42%	8	No data	No data	Major
R2UB2H	1,527.63	Upper Camp Branch Creek	None/Slight	Moderate	7%	2	0	10%	12	No data	No data	Moderate
R2UB2H	2,237.62	Upper Camp Branch Creek	None/Slight	Moderate	7%	2	0	10%	12	No data	No data	Moderate
R2UB2H	3,905.42	Upper Camp Branch Creek	None/Slight	Moderate	7%	2	0	10%	12	No data	No data	Moderate
R2UB2H	1,151.61	Buffalo Creek	None/Slight	None	2%	0	0	2%	12	No data	No data	Low
R2UB2H	2,257.18	Buffalo Creek	None/Slight	None	2%	0	0	2%	12	No data	No data	Low
R2UB2H	3,020.38	Buffalo Creek	None/Slight	None	2%	0	0	2%	12	No data	No data	Low
R2UB2H	1,084.10	Buffalo Creek	None/Slight	None	2%	0	0	2%	12	No data	No data	Low
R2UB2H	1,954.42	Buffalo Creek	None/Slight	None	2%	0	0	2%	12	No data	No data	Low
R2UB2H	1,792.55	Buffalo Creek	None/Slight	None	2%	0	0	2%	12	No data	No data	Low
R2UB2H	3,688.13	Buffalo Creek	None/Slight	None	2%	0	0	2%	12	No data	No data	Low
R2UB2H	63.40	Buffalo Creek-Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	94.09	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	2,091.22	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	24,698.26	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	1,248.44	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	133.60	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	640.20	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	1,276.21	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	1,294.20	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	168.82	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	79.87	Headwaters Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	1,483.55	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	None/Slight	None	7%	0	0	4%	12	No data	No data	Low
R2UB2H	19,027.02	Little Lynches River Between Camp Branch Creek and Haile Gold Mine Creek	None/Slight	None	7%	0	0	4%	12	No data	No data	Low
R2UB2H	28.04	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	None/Slight	None	64%	0	0	2%	12	No data	No data	Low
R2UB2H	31.63	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	None/Slight	None	64%	0	0	2%	12	No data	No data	Low

Cowardin	Impact (Linear Feet)	Subwatershed	Watershed Alteration		Change in Flows (by Subwatershed)						Duration of Impact	Combined Indirect Impact Factor
					Active Mining (Year 0-14)					Post Mining (After Year 14)		
			Long Term Topographic Change	Habitat Fragmentation	Maximum Change in Baseflows	Years of 10-20% Change in Total Flows	Years of >20% Change in Total Flows	Maximum Change in Total flows	Year of Maximum Change in Total Flows	Post Mining Duration of Impact Until Recovery		
R2UB2H	2,080.91	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	None/Slight	None	64%	0	0	2%	12	No data	No data	Low
R2UB2H	2,444.17	Little Lynches River between Haile Gold Mine Creek and unnamed tributary southeast of the Project boundary	None/Slight	None	64%	0	0	2%	12	No data	No data	Low
R2UB2H	18,767.88	Lower Camp Branch Creek	None/Slight	None	8%	0	0	9%	12	No data	No data	Low
R2UB2H	221.47	Lower Camp Branch Creek	None/Slight	None	8%	0	0	9%	12	No data	No data	Low
R2UB2H	787.30	Unnamed tributary near Camp Branch Creek	None/Slight	None	20%	2	0	12%	12	No data	No data	Moderate
R2UB2H	328.11	Unnamed tributary near western side of Champion Pit	Moderate	None	54%	10	2	26%	12	No data	No data	Major
R2UB2H	2,495.28	Unnamed tributary near western side of Champion Pit	Moderate	None	54%	10	2	26%	12	No data	No data	Major
R2UB2H	17,126.37	Unnamed tributary southeast of the Project boundary	None/Slight	None	64%	0	12	36%	12	No data	No data	Major
R2UB2H	3,099.58	Unnamed tributary southeast of the Project boundary	None/Slight	None	64%	0	12	36%	12	No data	No data	Major
R2UB2H	2,980.88	Unnamed tributary southeast of the Project boundary	None/Slight	None	64%	0	12	36%	12	No data	No data	Major
R2UB2H	1,357.70	Upper Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	1,439.08	Upper Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	3,753.43	Upper Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	1,244.99	Upper Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
R2UB2H	110.03	Upper Little Lynches River	None/Slight	None	No data	No data	No data	No data	No data	No data	No data	No data
											Total Major	**27,838.49 LF**
											Total Moderate	**8,457.97 LF**
											Total Moderate and Major =>	**36,296.46 LF**

Notes:
LF: Linear Feet

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Table K4-3 Indirect Impact Matrix Criteria for Streams

Stream Flows			
Maximum change in annual average baseflows (low flow conditions <0.25 cfs)	<20% Negligible	20-50% moderate change	>50% substantial change
Maximum change in annual average baseflows and total flows (normal flow conditions >0.25 cfs)	<10% Negligible	10-20% moderate change	>20% substantial change
Watershed Alterations			
Habitat Fragmentation	None	Moderate = some level of fragmentation in Upper Camp Branch and Lower Haile Gold Mine Creek	Major- Upper Haile Gold Mine Creek severed from downstream portion of HGH Creek with the exception of stream diversion pipe
Long Term Topographic Change	None/slight=slight loss of surface runoff/seepage from topographic changes in contributing watershed	Moderate change=some loss of surface runoff/seepage from topographic changes in contributing watershed	Major change=> source of contributing watershed for surface runoff and seepage is completely removed
Combined Indirect Impact Factor			
Combined Indirect Impact Factor	Low= no change or low for all variables; no habitat fragmentation and maximum change in baseflows and total flows is less than 10%	Moderate=Moderate habitat fragmentation; maximum change in baseflows and total flows > 10% but less than 20%	Major=Major habitat fragmentation; change in baseflows and total flows > 20%

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